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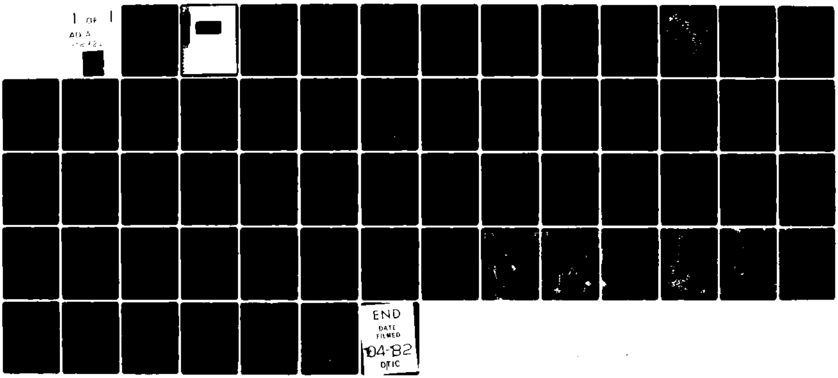

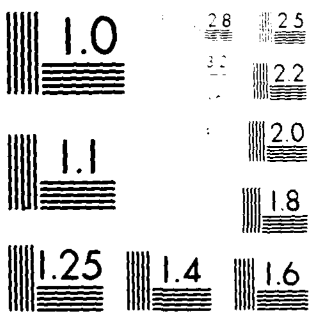
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GRAVITY SURVEY - WAH WAH VALLEY

UTAH

Prepared for:

U. S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

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3777 Long Beach Boulevard
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15 May 1981

Ertec

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Results of a gravity survey of the Wah Wah Valley of southwestern Utah indicate a north-south trending, eastward tilted half graben bounded by a major north-south trending fault along the western margin of the San Francisco Mountains. The maximum calculated thickness of alluvial fill in the valley is 4000 feet. The calculated thickness values are only approximations because little is known about the actual density distribution in and around the valley, and the assumed density contrast is based on an interpretation of [illegible].

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FOREWORD

Methodology and Characterization studies during Fiscal Years 1977 and 1978 (FY 77 and 78) included gravity surveys in 10 valleys, five in Arizona, two in Nevada, two in New Mexico, and one in California. The gravity data were obtained for the purpose of estimating the gross structure and shape of the basins and the thickness of the valley fill. There was also the possibility of detecting shallow rock in areas between boring locations. Generalized interpretations from these surveys were included in Ertec Western's (formerly Fugro National) Characterization reports (FN-TR-26a through e).

During the FY 77 surveys, measurements were made to form an approximate 1-mile grid over the study areas, and contour maps showing interpreted depth to bedrock were made. In FY 79, the decision was made to concentrate on verifying and refining suitable area boundaries. This decision resulted in a reduction in the gravity program. Instead of obtaining gravity data on a grid, the reduced program consisted of obtaining gravity measurements along profiles across the valleys where Verification studies were also performed.

The Defense Mapping Agency (DMA), St. Louis, was requested to provide gravity data from their library to supplement the gravity profiles. For Big Smoky, Hot Creek, and Big Sand Springs valleys, a sufficient density of library data was available to permit construction of interpreted contour maps instead of just two-dimensional cross sections.

In late summer of FY 79, supplementary funds became available to begin data reduction. At that time, inner zone terrain corrections were begun on the library data and the profiles from Big Smoky Valley, Nevada, and Butler and La Posa valleys, Arizona. The profile data from Whirlwind, Hamlin, Snake East, White River, Garden, and Coal valleys, Nevada, became available from the field in early October 1979.

A continuation of gravity interpretations was incorporated into the FY 80 and 81 programs, and the results are being summarized in a series of valley reports. Reports covering Nevada-Utah gravity studies are being numbered "E-TR-33-" followed by the abbreviation for the subject valley. In addition, more detailed reports of the results of FY 77 surveys in Dry Lake and Ralston valleys, Nevada, were prepared. Verification studies were continued in FY 80, and gravity studies were included in the program. DMA continued to obtain the field measurements, and there was a return to the grid pattern. The interpretation of the grid data allows the production of contour maps which are valuable in the deep basin structural analysis needed for computer modeling in the water resources program. The gravity

interpretations will also be useful in Nuclear Hardness and Survivability (NH&S) evaluations.

The basic decisions governing the gravity program are made by BMO following consultation with TRW, Inc., Ertec Western, and the DMA. Conduct of the gravity studies is a joint effort between DMA and Ertec Western. The field work, including planning, logistics, surveying, and meter operation is done by the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC), headquartered in Cheyenne, Wyoming. DMAHTC reduces the data to Simple Bouguer Anomaly (see Section A1.4, Appendix A1.0). The Defense Mapping Agency Aerospace Center (DMAAC), St. Louis, Missouri, calculates outer zone terrain corrections.

Ertec Western provides DMA with schedules showing the valleys with the highest priorities. Ertec Western also recommended locations for the profiles in the FY 79 studies with the provision that they should follow existing roads or trails. Any required inner zone terrain corrections are calculated by Ertec Western prior to making geologic interpretations.

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1.0 INTRODUCTION

1.1 OBJECTIVE

Gravity measurements were made in Wah Wah Valley for the purpose of estimating the overall shape of the structural basin, the thickness of alluvial fill, and the location of concealed faults. The estimates will be useful in modeling the dynamic response of ground motion in the basin and in evaluating groundwater resources.

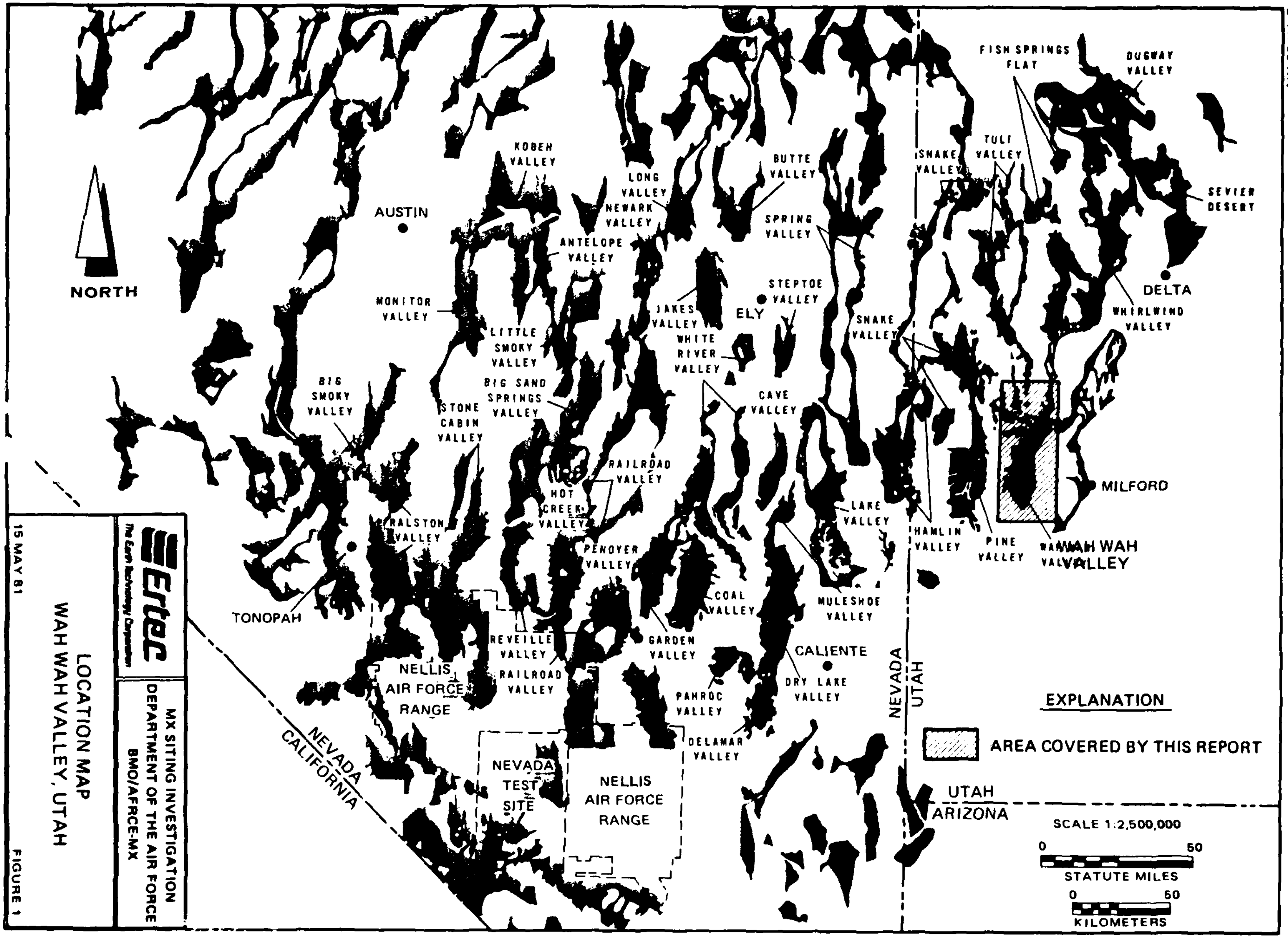
1.2 LOCATION

Wah Wah Valley is located in southwestern Utah (Figure 1) in Millard and Beaver counties, Utah. The town of Milford, Utah, is located approximately 10 miles east of the valley on Highway 21. Access throughout the valley is good due to an extensive network of well-maintained, unpaved roads. The valley is principally rangeland.

Wah Wah Valley is bounded on the west by the Wah Wah Mountains, on the east by the San Francisco Mountains, and on the north by the Confusion and House ranges (Figure 2). The area covered by this report lies between north latitudes 38° 20' and 38° 45' and west longitudes 113° 05' and 113° 40'. The north trending valley is approximately 32 miles (52 km) long and up to eight miles (13 km) wide.

1.3 SCOPE OF WORK

A geologic interpretation was made based on gravity data supplied from the Defense Mapping Agency Aerospace Center (DMAAC)



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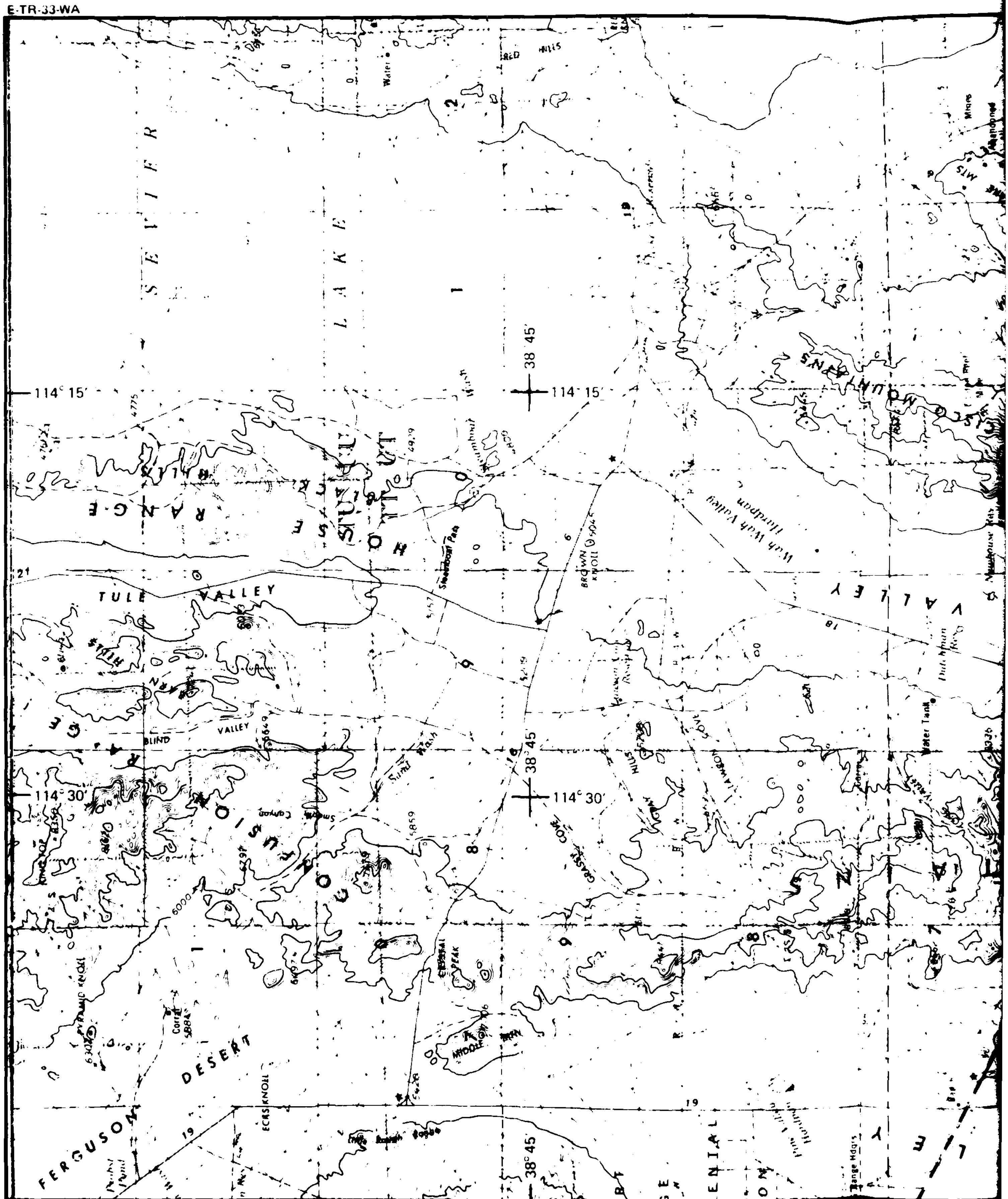
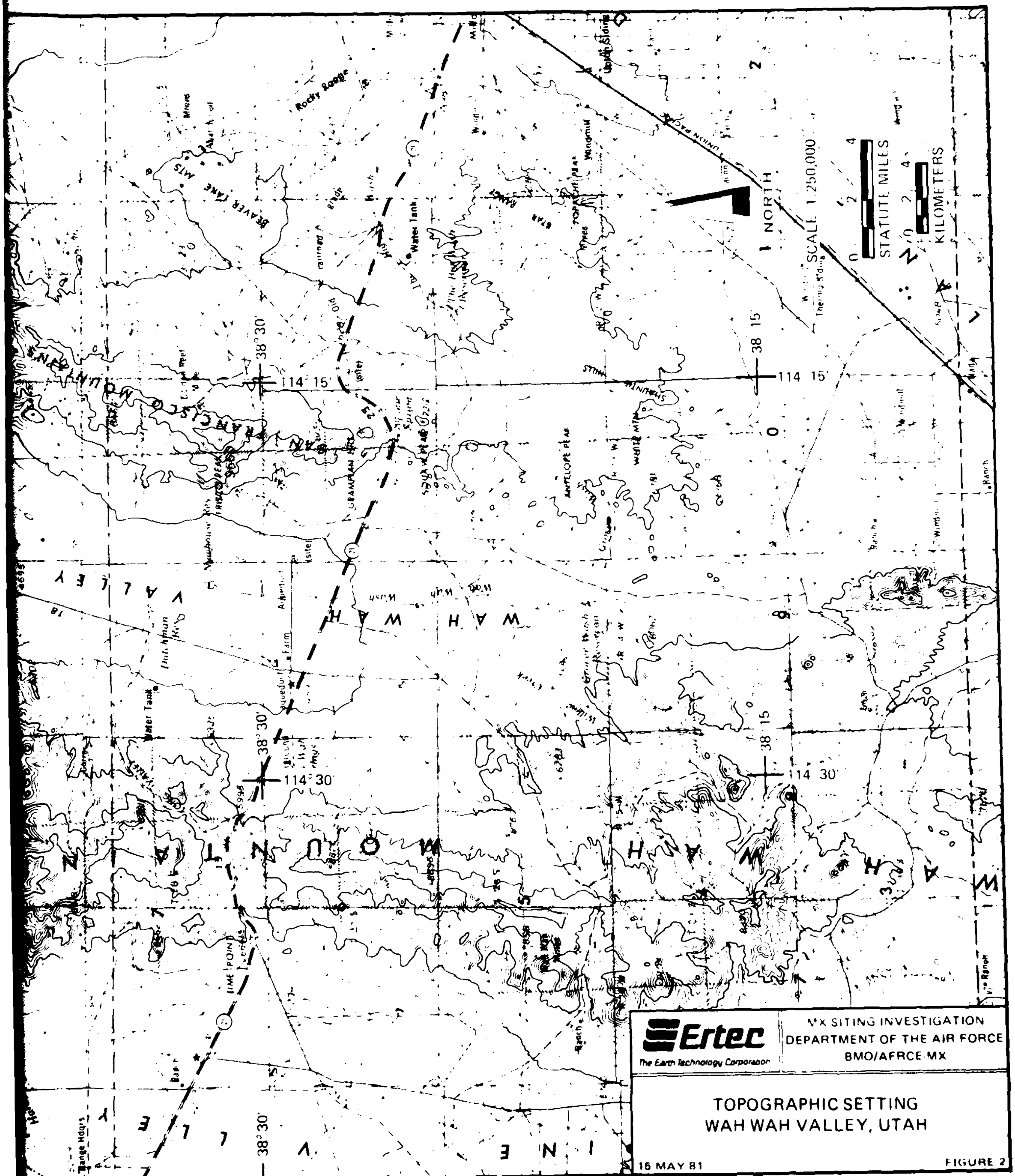
LOCATION MAP
WAH WAH VALLEY, UTAH

15 MAY 81

FIGURE 1


RED HILLS
SEVIER
LAKE
38°45'
114°15'
HOUSE RANGE
TULE VALLEY
BLIND VALLEY
38°45'
114°30'
BROWN KNOLL
Wah Wah Valley Hardpan
VALLEY
Water Tank
LAWSON COVE
GRASSY COVE
CENTRAL PEAK
MIDDLE MTN
PYRAMID KNOLL
FERGUSON
DESERT
ECKS KNOLL
Range Hdq's
38°45'
6000



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TOPOGRAPHIC SETTING
WAH WAH VALLEY, UTAH

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FIGURE 2

library and on new measurements made by the Defense Mapping Agency Hydrographic-Topographic Center/Geodetic Survey Squadron (DMAHTC/GSS). Wah Wah Valley and Pine Valley were studied together, with the results presented in separate reports. The rectangular region containing both valleys is the area between north latitudes 38° 00' and 38° 45' and west longitudes 113° 05' and 114° 00'.

There are 778 gravity stations in the region. All were used to establish a common regional gravity trend for the two valleys. The area covered by this report contains 367 gravity stations as listed in Appendix 2.0. Of these, 210 were from the DMAAC, and 157 were new measurements.

Following residual separation, the geologic modeling of the two valleys was done independently.

2.0 GRAVITY DATA REDUCTION

DMAHTC/GSS obtained the basic observations for the new stations and reduced them to Simple Bouguer Anomalies (SBA) as described in Appendix A1.0. Up to three levels of terrain corrections were applied to the new stations to convert the SBA to the Complete Bouguer Anomaly (CBA). Only the first two levels of terrain corrections described below were applied to the library stations.

First, the DMAAC, St.Louis, Missouri, used its library of digitized terrain data and a computer program to calculate corrections out to 104 miles (167 km) from each station. When the program could not calculate the terrain effects near a station, Ertec Western, Inc. (formerly Fugro National Inc.) used a ring template to estimate the effect of terrain within approximately 3000 feet (914 m) of the station. The third level of terrain corrections was applied to those stations where 10 feet (3 m) or more of relief was observed within 130 feet (40 m). In these cases, the elevation differences were measured in the field at a distance of 130 feet along six directions from the stations. These data were used by Ertec Western to calculate the effect of the very near relief.

3.0 GEOLOGIC SUMMARY

Wah Wah Valley is located in south-central Millard and north-central Beaver counties, Utah, within the Great Basin physiographic province. The Wah Wah Valley drainage basin is a closed basin bounded by drainage divides in the Wah Wah Mountains on the west and southwest, the Confusion and House ranges on the north, and the San Francisco Mountains on the east (Figure 2). The northeastern boundary of the basin is a broad, low ridge, which connects the northern end of the San Francisco Mountains with the southern end of the House Range. The ridge rises about 25 feet (7.6 m) above the floor of the Wah Wah Valley Hardpan and divides the surface drainage of the Wah Wah Valley basin from that of the Sevier Lake basin (Stephens, 1974). The valley trends generally north-south and is approximately 32 miles (52 km) long and 8 miles (13 km) wide.

Rocks that crop out in the adjacent mountains range in age from late Precambrian to late Tertiary-Quaternary. Exposed rocks in the southern end of Wah Wah Range and the San Francisco Mountains are composed primarily of extrusive lava and ash-flow tuffs of Tertiary age. There is a minor intrusive body of quartz monzonite, as well as extrusive mafic to felsic lava flows and ignimbrites (Stephens, 1974; and Hintze, 1963) of Tertiary age in the Frisco Peak area. Rocks of the Wah Wah Mountains, to the west, are similar to those in the San Francisco Mountains and generally dip at low angles toward the north or northeast (Stephens, 1974).

From late Precambrian to late Permian time, a westward thickening wedge of clastic and carbonate sediments was deposited in western Utah along a north-to-northeast trending continental shelf. Thrusting and faulting began to the west of the region in the Jurassic and terminated to the east with late Precambrian and early Paleozoic rocks overthrusting late Paleozoic strata during the Cretaceous Sevier Orogeny (Thorman and Ketner, 1979). Beginning in the Miocene, extensional block faulting began in western Utah and was accompanied by extrusion of felsic and mafic-to-felsic volcanic flows and explosive ignimbrites.

The present day geologic structure of Wah Wah Valley is typical of the Great Basin tectonic province in that it is a result of late Tertiary and Quaternary block faulting due to tensional stresses directed in an east-west or northwest-southeast direction. The valley occupies the down-to-the-east tilted portion of a fault block with the Wah Wah Mountains to the west being the uplifted portion of the block.

According to Stephen (1974) the valley floor is covered by approximately 2500 feet (762 m) of late Tertiary and Quaternary alluvium where, as this report depicts, the valley floor is being covered by approximately 4000 feet (1219 m) of alluvial material. This alluvial material comprises fan and channel deposits of coarse sands and gravel and lactustrine deposits. These alluvial deposits are interbedded with volcanic flows. Surficial Quaternary deposits include alluvial lacustrine (ancient Lake Bonneville) and playa deposits of gravel, clay, and silt.

4.0 INTERPRETATION

The basis of interpretation is the Complete Bouguer Anomaly (CBA) shown in Drawing 1. The CBA is defined in Appendix A1.4.

Mathematical treatment of irregularly spaced data is inefficient. In order to simplify the computer processing, the station CBA and elevation data are reduced to sets of values at uniformly spaced points (nodes) in geographic array, or grid. Values at each node are calculated from the station data within a circular area around the node. A bell-shaped weighting function assigns greater weight to the nearer data points. The grid-point spacing is chosen to match the average data spacing. A 1.2-mile (2-km) grid spacing was used for this analysis.

4.1 REGIONAL-RESIDUAL SEPARATION

A fundamental part of the gravity interpretation is the separation of the local effects of the valley and its fill from regional effects. The CBA contains long-wavelength components from deep and broad geologic structures extending far beyond the valley. These long-wavelength components, called the regional gravity, were approximated by upward continuation of the gravity field. Upward continuations were made to successively higher elevations until the negative anomaly from the valley was essentially smoothed out. The final continuation was calculated at an elevation of 140,000 feet (42,672 m). This regional field was subtracted from the CBA and the resulting residual gravity anomaly was adjusted by a constant -5.0 milligals so

that the zero residual would fit approximately the existing rock outcrops.

4.2 DENSITY SELECTION

The construction of a geologic model from the residual anomaly requires selection of density values representative of the alluvial fill and of the underlying rock. Because only very generalized density information is available, the geologic interpretation of the gravity data can be only a coarse approximation. Average in situ density of the fill material was measured in seven shallow *borings* (Table 1) at depths ranging from 20 feet to 210 feet (6 m to 61 m). The observed density range for the soil was 1.9 to 2.2 g/cm^3. To account for compaction (Woollard, 1962; and Grant and West, 1965), 2.3g/cm^3 was used in the modeling process.

Based on the geology of the surrounding mountain ranges, the basement rocks underlying Wah Wah Basin are composed of Precambrian quartzites and shales and Paleozoic carbonates and siliceous clastic strata. Basement rocks throughout the Great Basin primarily comprise Precambrian and Paleozoic siliceous clastic and carbonate strata with densities generally between 2.6 to 2.9 g/cm^3. The Paleozoic carbonate rocks in Nevada and Utah are generally reported to be relatively high in density, on the order of 2.8 g/cm^3. This value was selected to represent the density of the basement rock. The density contrast used for modeling was -0.50 g/cm^3.

VERIFICATION BORING RESULTS			
BORING NUMBER	TOTAL HOLE DEPTH feet (meters)	DENSITY g/cm^3	REMARKS
WA-B-1	160/(49)	2.00	NO ROCK ENCOUNTERED
WA-B-2	152/(46)	2.00	NO ROCK ENCOUNTERED
WA-B-3	160/(49)	2.20	NO ROCK ENCOUNTERED
WA-B-4	160/(49)	2.10	NO ROCK ENCOUNTERED
WA-B-5	39/(12)	2.20	NO ROCK ENCOUNTERED
WA-B-6	26/(8)	1.90	NO ROCK ENCOUNTERED
WA-B-7	20/(6)	2.10	NO ROCK ENCOUNTERED

SELECTED VERIFICATION SEISMIC REFRACTION RESULTS *			
LINE NUMBER	DEEPEST LAYER fps (mps)	@	feet (meters)
WA-S-2	9650 (2941)	@	78 (24)
WA-S-5	8550 (2606)	@	22 (7)
WA-S-10	16500 (5029)	@	142 (43)
WA-S-20	8500 (2591)	@	72 (22)

*LOCATIONS MARKED ON DRAWING 2.

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GEOTECHNICAL DATA
WAH WAH VALLEY, UTAH

15 MAY 81

TABLE 1

4.3 MODELING

Modeling was done with the aid of a computer program which iteratively calculates a three-dimensional solution of gravity anomaly data (Cordell, 1970). The gravity anomaly is represented by discrete values on a two-dimensional grid. The source of the anomaly (the volume of low-density valley fill) is represented by a set of vertical prism elements. The tops of the prisms lie in a common horizontal plane. The bottoms of the prisms collectively represent the bottom of the valley fill. Each prism has a cross-sectional area equal to one grid square and a uniform density. A grid square of 1.2 miles by 1.2 miles (2 km by 2 km) was selected as representative of the gravity station distribution. Computations were made for five iterations of mutually interactive prism adjustment. The root-mean-square error for the entire grid was less than 0.5 milligal.

Given a residual anomaly, the calculated thickness of the valley fill depends upon the density contrast (i.e., fill density minus rock density) used. Since neither density is perfectly known, nor even uniform, the calculated thickness should be expected to contain a corresponding degree of uncertainty. Another source of error is in modeling the valley as just a simple alluvium basement rock system because there is widespread volcanic material around the valley. The western end of profile A-A[1] (Drawing 1 and 2) is on extensive volcanic flows typical of those that surround Wah Wah Valley.

BORING FROM LITERATURE

I.D.	COMPANY	LOCATION	REMARKS
BORING (A)	VON GLAHN	SE¼ of SEC. 33 T24S-R13W MILLARD COUNTY, UTAH	1971 FT (600m) SHALE, GRAY, VERY STICKY
BORING (B)	U.S. BUREAU OF LAND MANAGEMENT	SW¼ of SEC. 7 T24S-R14W MILLARD COUNTY, UTAH	656 FT (200m) CONGLOMERATE, WHITE PROPHYRY
BORING (C)	U.S. BUREAU OF LAND MANAGEMENT	NE¼ of SEC. 27 T27S-R14W BEAVER COUNTY, UTAH	500 FT (152m) SILT, SAND, GRAVEL
BORING (D)	EARTH SCIENCES INC.	NE¼ of SEC. 11 T28S-R14W BEAVER COUNTY, UTAH	1472 FT (449m) CLAY, GRAVEL
BORING (E)	ERTEC WESTERN WA-IO-5	NE¼ of SEC. 25 T26S-R14W BEAVER COUNTY, UTAH	1250 FT (381m) REDDISH BROWN SAND
BORING (F)	ERTEC WESTERN WA-IT-5	SE¼ of SEC. 28 T27S-R14W BEAVER COUNTY, UTAH	1400 FT (427m) REDDISH GRAY TO BROWN SAND

*LOCATIONS MARKED IN DRAWING 2.

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BORINGS FROM LITERATURE*
WAH WAH VALLEY, UTAH

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TABLE 2

Seven shallow borings, four seismic refraction lines (Table 1), and six borings (Table 2) were used as constraints in the modeling process. Their locations are marked in Drawing 2. The seismic refraction lines located near the mountain flanks recorded high velocities which may represent the bedrock material. The alluvial-fill material in the center of the valley is at least 500 to 1500 feet (152 to 457 m) thick according to the borings listed in Table 2. The calculated thickness of fill (or depth to rock) is contoured in Drawing 2.

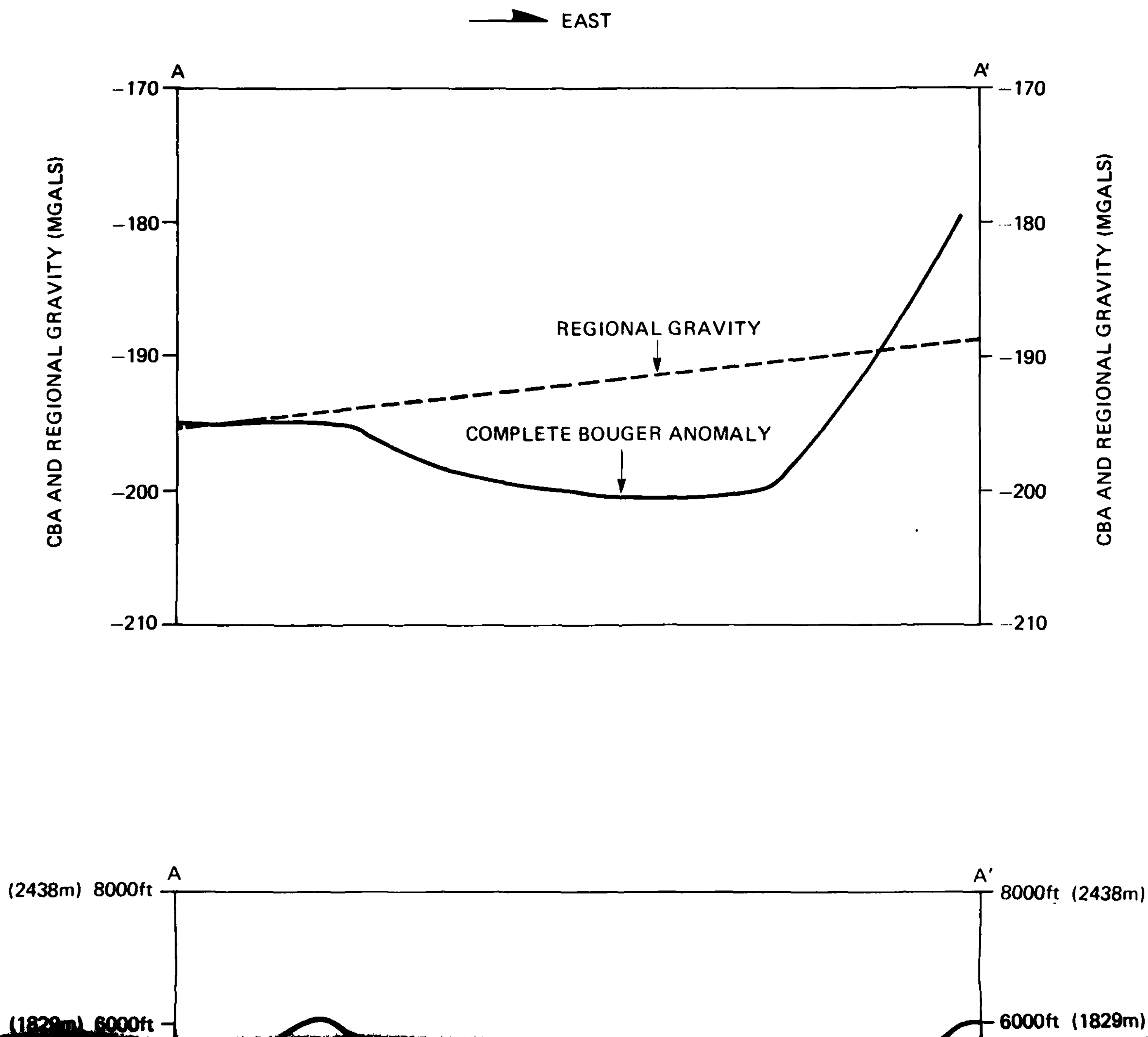
4.4 DISCUSSION OF RESULTS

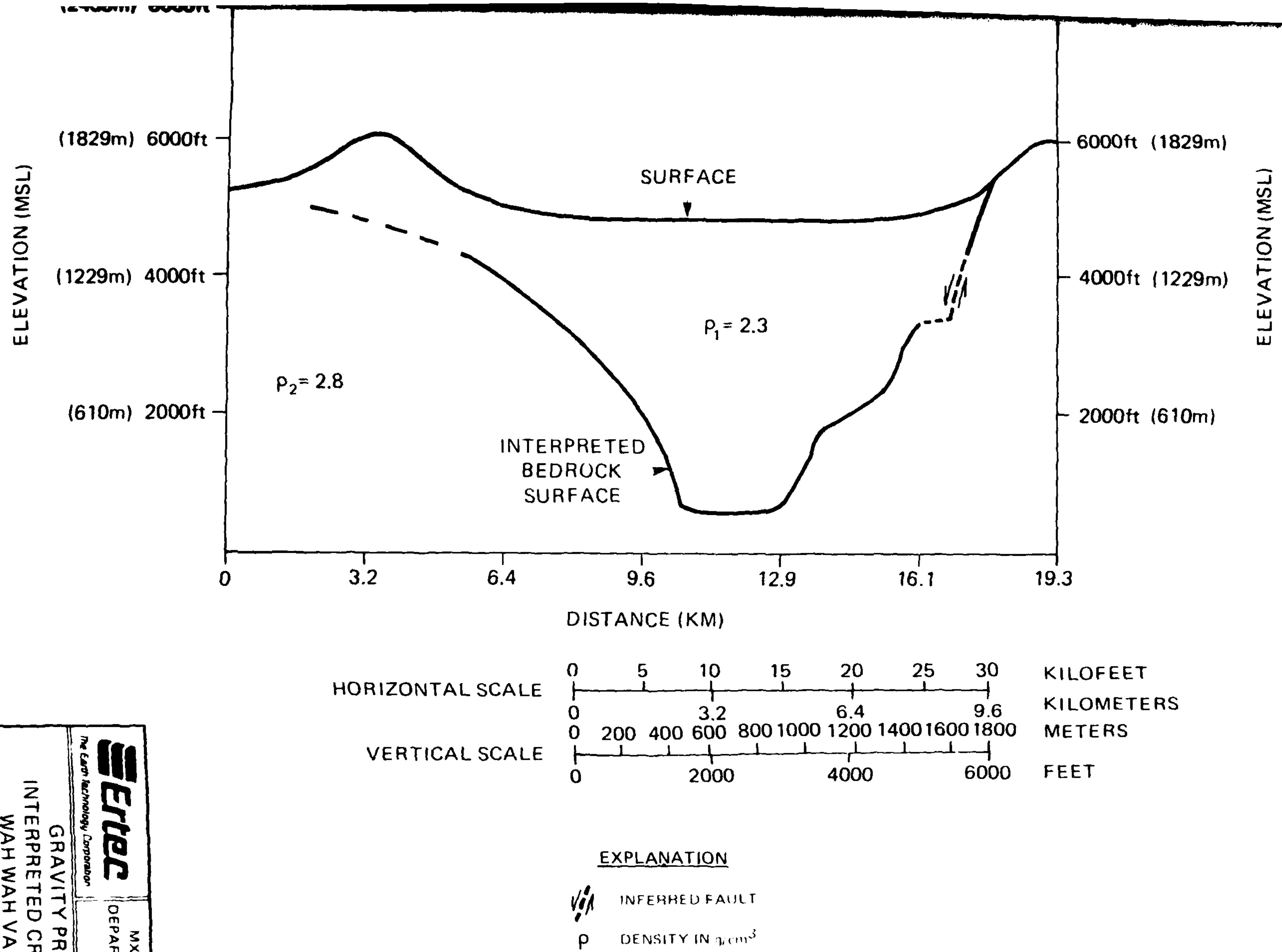
This interpretation was aided by regional geologic information from published reports, aerial photographs, and field reconnaissance which indicates the distribution of surface faults. The second vertical derivative of the CBA field was calculated to assist in the structural interpretation. Placement of faults was guided by the zero contour which marks the steepest part of the input CBA field.

The depth-to-rock contours (Drawing 2) depict an elongate linear basin coinciding with the alluvial fill between the San Francisco and Wah Wah Mountains. The interpreted shape and structure of Wah Wah Valley is typical of the Basin and Range province. The deepest part of the basin is adjacent to the central San Francisco Mountains where it reaches depths greater than 4000 feet (1219 m). In general, the gravity data (Drawing 1) indicate that the basin is an eastward tilted fault-block structure, with the eastern side of the basin being typified by

closely spaced and parallel contours while the remainder of the basin shows irregular, widely spaced contours.

The major geological structure in Wah Wah Valley lies below the eastern side of the valley near the base of San Francisco Mountains. The linear nature of the steep gravity gradient suggests a major fault system along the valley margin (Drawing 2). The more widely spaced, irregular gravity contours on the western side of the valley reflect a relatively gentle eastward dip of the bedrock surface extending from the Wah Wah Mountains beneath the alluvium. An east-west cross sectional view (Figure 3) across the deepest part of the modeled valley depicts the block-fault structure suggested by the gravity data. This geological model is consistent with published data (Schmoker, 1971; and Stephens, 1974). Geologic field reconnaissance supports this interpretation in that a major late Quaternary fault was observed on the eastern side of the valley but only short scattered faults and lineaments are present in the remainder of the valley.


EAST
A
A'
-170
-180
-190
-200
-210
CBA AND REGIONAL GRAVITY (MGALS)
REGIONAL GRAVITY
COMPLETE BOUGER ANOMALY
(2438m) 8000ft
8000ft (2438m)
(1829m) 6000ft
6000ft (1829m)



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GRAVITY PROFILE A A'
INTERPRETED CROSS – SECTION
WAH WAH VALLEY, UTAH

15 MAY81

FIGURE 3

5.0 CONCLUSIONS

The interpretation of Wah Wah Valley gravity data indicates a north-south trending, eastward tilted fault block bounded by a major north-south trending fault along the western flanks of the San Francisco Mountains. The maximum calculated thickness of alluvial fill in the valley is 4000 feet (1219 m). The calculated bedrock depths are only approximations because little is known about the actual density distribution in and around the valley, and the residual gravity anomaly is based on an interpreted regional field. An average density contrast of -0.50 g/cm^3 between the alluvium and bedrock was used to calculate the thickness of the valley-fill material. If future studies acquire more extensive density data or measure actual depths to bedrock in deep parts of the valley, the gravity interpretation can be refined.

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APPENDIX A1.0

GENERAL PRINCIPLES OF THE GRAVITY EXPLORATION METHOD

A1.0 GENERAL PRINCIPLES OF THE GRAVITY EXPLORATION METHOD

A1.1 GENERAL

A gravity survey involves measurement of differences in the gravitational field between various points on the earth's surface. The gravitational field values being measured are the same as those influencing all objects on the surface of the earth. They are generally associated with the force which causes a 1 gm mass to be accelerated at 980 cm/sec^2. This force is normally referred to as a 1-g force.

Even though in many applications the gravitational field at the earth's surface is assumed to be constant, small but distinguishable differences in gravity occur from point to point. In a gravity survey, the variations are measured in terms of milligals. A milligal is equal to 0.001 cm/sec^2 or 0.00000102 g. The differences in gravity are caused by geometrical effects, such as differences in elevation and latitude, and by lateral variations in density within the earth. The lateral density variations are a result of changes in geologic conditions. For measurements at the surface of the earth, the largest factor influencing the pull of gravity is the density of all materials between the center of the earth and the point of measurement.

To detect changes produced by differing geological conditions, it is necessary to detect differences in the gravitational field as small as a few milligals. To recognize changes due to

geological conditions, the measurements are "corrected" to account for changes due to differences in elevation and latitude.

Given this background, the basic concept of the gravitational exploration method, the anomaly, can be introduced. If, instead of being an oblate spheroid characterized by complex density variations, the earth were made up of concentric, homogeneous shells, the gravitational field would be the same at all points on the surface of the earth. The complexities in the earth's shape and material distribution are the reason that the pull of gravity is not the same from place to place. A difference in gravity between two points which is not caused by the effects of known geometrical differences, such as in elevation, latitude, and surrounding terrain, is referred to as an "anomaly."

An anomaly reflects lateral differences in material densities. The gravitational attraction is smaller at a place underlain by relatively low density material than it is at a place underlain by a relatively high density material. The term "negative gravity anomaly" describes a situation in which the pull of gravity within a prescribed area is small compared to the area surrounding it. Low-density alluvial deposits in basins such as those in the Nevada-Utah region produce negative gravity anomalies in relation to the gravity values in the surrounding mountains which are formed by more dense rocks.

The objective of gravity exploration is to deduce the variations in geologic conditions that produce the gravity anomalies identified during a gravity survey.

A1.2 INSTRUMENTS

The sensing element of a LaCoste and Romberg gravimeter is a mass suspended by a zero-length spring. Deflections of the mass from a null position are proportional to changes in gravitational attraction. These instruments are sealed and compensated for atmospheric pressure changes. They are maintained at a constant temperature by an internal heater element and thermostat. The absolute value of gravity is not measured directly by a gravimeter. It measures relative values of gravity between one point and the next. Gravitational differences as small as 0.01 milligal can be measured.

A1.3 FIELD PROCEDURES

The gravimeter readings were calibrated in terms of absolute gravity by taking readings twice daily at nearby USGS gravity base stations. Gravimeter readings fluctuate because of small time-related deviations due to the effect of earth tides and instrument drift. Field readings were corrected to account for these deviations. The magnitude of the tidal correction was calculated using an equation suggested by Goguel (1954):

$$C = P + N\cos\phi\,(\cos\phi + \sin\phi) + S\cos\phi\,(\cos\phi - \sin\phi)$$

where C is the tidal correction factor, P, N, and S are time-related variables, and ϕ is the latitude of the observation point. Tables giving the values of P, N, and S are published annually by the European Association of Exploration Geophysicists.

The meter drift correction was based on readings taken at a designated base station at the start and end of each day. Any difference between these two readings after they were corrected for tidal effects was considered to have been the result of instrumental drift. It was assumed that this drift occurred at a uniform rate between the two readings. Corrections for drift were typically only a few hundredths of a milligal. Readings corrected for tidal effects and instrumental drift represented the observed gravity at each station. The observed gravity values represent the total gravitational pull of the entire earth at the measurement stations.

A1.4 DATA REDUCTION

Several corrections or reductions are made to the observed gravity to isolate the portion of the gravitational pull which is due to the crustal and near-surface materials. The gravity remaining after these reductions is called the "Bouguer Anomaly." Bouguer Anomaly values are the basis for geologic interpretation. To obtain the Bouguer Anomaly, the observed gravity is adjusted to the value it would have had if it had been measured at the geoid, a theoretically defined surface which approximates the surface of mean sea level. The difference between the "adjusted" observed gravity and the gravity at the geoid calculated for a theoretically homogeneous earth is the Bouguer Anomaly.

Four separate reductions, to account for four geometrical effects, are made to the observed gravity at each station to arrive at its Bouguer Anomaly value.

a. Free-Air Effect: Gravitational attraction varies inversely as the square of the distance from the center of the earth. Thus, corrections must be applied for elevation. Observed gravity levels are corrected for elevation using the normal vertical gradient of:

$$FA = -0.09406 \text{ mg/ft } (-0.3086 \text{ milligals/meter})$$

where FA is the free-air effect (the rate of change of gravity with distance from the center of the earth). The free-air correction is positive in sign since the correction is opposite the effect.

b. Bouguer Effect: Like the free-air effect, the Bouguer effect is a function of the elevation of the station, but it considers the influence of a slab of earth materials between the observation point on the surface of the earth and the corresponding point on the geoid (sea level). Normal practice, which is to assume that the density of the slab is 2.67 grams per cubic centimeter was followed in these studies. The Bouguer correction (B_c), which is opposite in sign to the free-air correction, was defined according to the following formula.

$$B_c = 0.01276 \ (2.67) \ h_f \text{ (milligals per foot)}$$

$$B_c = 0.04185 \ (2.67) \ h_m \text{ (milligals per meter)}$$

where h_f is the height above sea level in feet and h_m is the height in meters.

c. Latitude Effect: Points at different latitudes will have different "gravities" for two reasons. The earth (and the geoid) is spheroidal, or flattened at the poles. Since points at higher latitudes are closer to the center of the earth than points near the equator, the gravity at the higher latitudes is larger. As the earth spins, the centrifugal acceleration causes a slight decrease in gravity. At the higher latitudes where the earth's radii are smaller, the centrifugal acceleration diminishes. The gravity formula for the Geodetic Reference System, 1967, gives the theoretical value of gravity at the geoid as a function of latitude. It is:

$$g = 978.0381\ (1 + 0.0053204 \sin^2 \phi - 0.0000058 \sin^2 2\phi) \text{ gals}$$

where g is the theoretical acceleration of gravity and ϕ is the latitude in degrees. The positive term accounts for the spheroidal shape of the earth. The negative term adjusts for the centrifugal acceleration.

The previous two corrections (free air and Bouguer) have adjusted the observed gravity to the value it would have had at the geoid (sea level). The theoretical value at the geoid for the latitude of the station is then subtracted from the adjusted observed gravity. The remainder is called the Simple Bouguer Anomaly (SBA). Most of this gravity represents the effect of material beneath the station, but part of it may be due to irregularities in terrain (upper part of the Bouguer slab) away from the station.

d. Terrain Effect: Topographic relief around the station has a negative effect on the gravitational force at the station. A nearby hill has upward gravitational pull and a nearby valley contributes less downward attraction than a nearby material would have. Therefore, the corrections are always positive. Corrections are made to the SBA when the terrain effects were 0.1 milligal or larger. Terrain corrected Bouguer values are called the Complete Bouguer Anomaly (CBA). When the CBA is obtained, the reduction of gravity at individual measurement points (stations) is complete.

A1.5 INTERPRETATION

To interpret the gravity data, the portion of the CBA that might be caused by the light-weight, basin-fill material must be separated from that caused by the heavier bedrock material which forms the surrounding mountains and presumably the basin floor. The first step is to create a regional field. A regional field is an estimation of the values the CBA would have had if the light-weight sediments (the anomaly) had not been there. Since the valley-fill sediments are absent at the stations read in the mountains, one approach is to use the CBA values at bedrock stations as the basis for constructing a second order polynomial surface to represent a regional field over the valley.

Where there are insufficient bedrock stations to define a satisfactory regional trend, another approach is to estimate the regional by the process of upward continuation of the CBA field.

In Potential Theory, a field normal to a surface, regardless of its actual source, may be considered as originating in an areal distribution of mass on that surface. If the field strength is known the surface density of mass (grams per square centimeter) can be calculated. The observed gravity field at the surface of the earth approximately fulfills the requirements of this theory: thus the observed (Bouguer anomaly) field can be used to compute a surficial distribution of mass which would reproduce the field, and most importantly, account for the gravity field anywhere above the surface of observation. On this basis, the Bouguer anomaly field is readily "continued" to level surfaces above the ground.

An important property of such "upward continuation" is that the resultant field (which can be represented by a contour map), with increasing altitudes of continuation, changes more with respect to shallow sources than it does with respect to deeper sources. The anomalous parts of the field ascribed to shallow density distribution tend to vanish as the continuation is carried upward whereas the field produced by deeper sources changes only slightly, so that upward continuations produce "regional"-type fields.

The difference between the CBA and the regional field is called the "residual" field or residual anomaly. The residual field is the interpreter's estimation of the gravitational effect of the geologic anomaly. The zero value of the residual anomaly is not exactly at the rock outcrop line but at some distance on the

"rock" side of the contact. The reason for this is found in the explanation of the terrain effect. There is a component of gravitational attraction from material which is not directly beneath a point.

If the "regional" is well chosen, the magnitude of the residual anomaly is a function of the thickness of the anomalous (fill) material and the density contrast. The density contrast is the difference in density between the alluvial and bedrock material. If this contrast were known, an accurate calculation of the thickness could be made. In most cases, the densities are not well known and they also vary within the study area. In these cases, it is necessary to use typical densities for materials similar to those in the study area.

If the selected average density contrast is smaller than the actual density contrast, the computed depth to bedrock will be greater than the actual depth and vice-versa. The computed depth is inversely proportional to the density contrast. A ten percent error in density contrast produces a ten percent error in computed depth. An iterative computer program is used to calculate a subsurface model which will yield a gravitational field to match (approximately) the residual gravity anomaly.

The second vertical derivative (SVD) of gravitational field is used to aid the interpreter in evaluating the subsurface mass distribution. Once the CBA field has been projected onto a uniform grid system, its SVD at the grid nodes is readily computed.

In accordance with La Place's Equation in Free Space, the negative of the second vertical derivative is equal to the sums of the second derivatives in the x-direction and in the y-direction. The second vertical derivative is an indication of the curvature of the Bouguer anomaly field. In particular the zero-value of the SVD indicates the inflection in the field as it changes from "concave-upward" (algebraically negative SVD) to "convex-upward" (algebraically positive SVD). In a general way the zero SVD falls on the tightest contours of the field and where contours are nearly parallel its location can be established by eye. However, where contours diverge, converge, or change direction this is not always so readily done. The zero SVD contour line may be an indicator of a line of faulting, the pinchout of a stratum, truncation of a stratum at an unconformity or merely a marked change in shape or in density of a geologic unit.

APPENDIX A2.0

WAH WAH VALLEY, UTAH

GRAVITY DATA

WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN ELEV +CODE	TER-COR IN/OUT NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
0246	384500	113259052090T	0 75429163	28868155743205810	-1060	81255
0211	383000	113295055141T	0 219426403	28271151101203606	-630	80779
001	383010	113300055876T	0 240426423	28199150700203620	-350	80830
1002	383020	113143066880T	0 299426383	30481144908203635	4170	81679
0079	383025	113111060659T	0 144426381	30947148033203642	1440	80914
0214	383050	113253048199T	0 143426479	28884154630203679	-3700	80003
0217	383050	113275050781T	0 191426488	28564153594203679	-2310	80561
0413	383054	113 56355039T	0 147426416	31743152539203685	610	82007
0080	383075	113105259731T	0 142426509	31034149329203745	1760	81542
001	383100	113319061135T	0 377426597	27927147840203753	1580	81127
0216	383110	113263048671T	0 169426594	28742154654203767	-3320	80249
2351	383112	113344764311T	0 269426630	27554145903203770	2620	80969
0114	383130	113 59056391T	0 173426558	31707151985203797	1220	82183
0015	383143	113249747749T	0 148426650	28937155058203816	-3830	80028
0115	383150	113 71062959T	0 225426599	31534148221203826	3610	82375
0335	383160	113 94060161T	0 132426625	31200149579203841	2320	81952
0333	383160	113117061181T	0 163426633	30866148290203841	1990	81303
1004	383170	113168091791T	02985426669	30125127848203855	10320	82025
0215	383170	113228047510T	0 155426692	29253154826203855	-4330	79615
0218	383180	113271049649T	0 253426726	28629154262203870	-2900	80423
0332	383190	113109059721T	0 147426686	30983149512203885	1790	81587
0081	383227	113101358320T	0 142426751	31097150762203939	1670	81942
0016	383244	113246447851T	0 140426835	28989155121203964	-3820	80000
0100	383249	113204648491T	0 335426829	29597155175203971	-3170	80625
1011	383250	113183060879T	0 725426823	29911148904203973	2180	82165
1012	383250	113217047159T	0 200426835	29417155396203973	-4210	79910
0220	383250	113282054311T	0 256426860	28472151435203973	-1440	80286
0121	383260	113 8049058T	0 78426782	32453154855203988	-2980	80368
0118	383260	113 28049249T	0 101[illegible]26788	32163155469203988	-2180	81121
0117	383260	113 39050141T	0 120426792	32003155577203988	-1240	81780
0116	383260	113 49052149T	0 151426795	31858154993203988	50	82431
0219	383270	113268050991T	0 182426892	28677153476204002	-2550	80242
0409	383300	113111559619T	0 169426890	30952150230204046	2250	82109
0221	383300	113244047900T	0 137426938	29027155209204046	-3770	80027
0120	383350	113 14048990T	0 77426950	32370155189204120	-2840	80527
0320	383350	113 61052749T	0 168426965	31687154904204120	390	82588
0017	383368	113241747871T	0 134427063	29064155568204146	-3540	80264
0083	383373	113 92256079T	0 130427018	31235153187204154	1770	82800
0119	383380	113 28049199T	0 92427010	32168155297204164	-2580	80732
0331	383390	113 74054449T	0 152427025	31500153980204164	1020	82622
0248	383330	113187055610T	0 445427065	29859152112204164	250	81745

WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN / ELEV. +CODE	TER-COR. IN/OUT	NORTH UTM / EAST UTM / OBSV GRAV / THEO GRAV	FAA	CBA +1000
0082	383386	113110358871T	0	173427049 30973151111204173	2300	82423
0247	383390	113197051138T	0	296427087 29714154016204178	-2050	80806
0101	383392	113209847051T	0	215427095 29528156226204181	-3690	80475
0223	383430	113228046870T	0	143427172 29266156165204237	-3980	80183
0222	383430	113239047789T	0	131427177 29106155876204237	-3400	80431
0226	383430	113278054439T	0	216427192 28540151774204237	-1250	80406
0321	383440	113 50051099T	0	106427128 31851154918204252	-1260	81416
0407	383441	113122362300T	0	224427155 30801149289204253	3630	82624
0408	383450	113135467480T	0	370427176 30611146333204267	5530	82900
0406	383454	113106558419T	0	155427173 31031151661204273	2330	82575
0224	383470	113249048921T	0	137427254 28963155606204296	-2660	80787
1005	383480	113 95056309T	0	119427217 31199153078204311	1720	82659
0330	383490	113 96056309T	0	123427218 31185153104204311	1750	82683
0249	383490	113261051270T	0	151427296 28789154482204325	-1610	81061
0225	383510	113276054331T	0	198427339 28573152299204355	-940	80728
0229	383510	113294059131T	0	285427346 28311149134204355	390	80525
0414	383525	113 71752871T	0	101427293 31539154823204377	170	82261
0323	383530	113 28049239T	0	79427287 32174155686204384	-2370	80909
0322	383530	113 39050259T	0	80427291 32014155231204384	-1870	81070
0227	383530	113280055390T	0	213427377 28515151455204384	-820	80503
0228	383530	113284056270T	0	232427379 28457151003204384	-440	80602
0415	383540	113 61351959T	0	102427317 31691154995204399	-520	81862
1010	383560	113 89054482T	0	116427363 31290154310204428	1120	82676
1009	383580	113 98055801T	0	134427403 31160153817204458	1840	82964
1006	383580	113 99055820T	0	144427404 31145153798204458	1840	82964
0018	383583	113233847339T	0	123427458 29189156859204462	-3060	80913
1013	383590	113184050200T	0	280427452 2991215580520447[illegible]	-1440	81720
0329	383610	113117059711T	0	198427465 30885151497204502	3150	83008
0232	383610	113233047090T	0	124427507 29202157142204502	-3050	81004
0230	383620	113299061270T	0	328427551 28244148378204516	1480	80938
0328	383640	113108057569T	0	163427518 31017152914204546	2510	83053
0231	383660	113231046821T	0	123427599 29233157485204575	-3040	81113
0416	383664	113 52250541T	0	85427543 31828155911204581	-1120	81725
0327	383670	113 94055131T	0	132427568 31222154445204590	1700	83052
0417	383682	113121560449T	0	238427600 30823151127204608	3370	83008
0133	383700	113 84053419T	0	122427620 31368155424204634	1030	82952
0233	383700	113216046381T	0	118427667 29453157417204634	-3580	80718
1008	383710	113 87053848T	0	164427640 31325155283204649	1280	83094
0019	383717	113228646650T	0	117427704 29271157733204659	-3030	81167
0262	383760	113267052979T	0	217427798 28716154320204722	-560	81587
0234	383780	113205046362T	0	114427811 29616157569204752	-3560	80744

WAH WAH VALLEY GRAVITY DATA

STATION IDENT	LAT. DEG MIN	LONG DEG MIN ELEV +CODE	TER-COR IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
0326	383790	113 11048609T	0	63427763	32431157316204766	-1720	81773
0325	383790	113 28048809T	0	68427768	32185157681204766	-1160	82258
0324	383790	113 45049560T	0	75427774	31938157098204766	-1040	82135
0134	383790	113 97060121T	0	201427791	31184151587204766	3360	83081
0239	383790	113172049459T	0	216427818	30095157201204766	-1030	82316
0418	383816	113122856220T	0	283427848	30810153510204805	1580	82703
0020	383854	113217446841T	0	97427953	29440157767204860	-3020	81097
0238	383870	113172047441T	0	172427966	30099157966204884	-2280	81712
0237	383870	113183046591T	0	135427970	29940157937204884	-3110	81135
0235	383870	113194046381T	0	115427974	29780157853204884	-3390	80905
0236	383870	113205046401T	0	101427978	29620157888204884	-3340	80941
0261	383870	113261050161T	0	149427999	28808156259204884	-1430	81609
0044	383874	113 39248930T	0	72427927	32026158023204890	-830	82552
0132	383890	113 61050420T	0	108427946	31710157608204899	130	83058
0136	383890	113106054311T	0	199427979	31057155326204913	1490	83189
0419	383894	113133253619T	0	170427996	30663155054204919	560	82460
0250	383910	113237048031T	0	101428064	29158157696204943	-2050	81661
0021	383971	113201846549T	0	89428163	29672158244205032	-2990	81219
0385	383980	113135051401T	0	127428156	30641156591205046	-100	82507
0137	383990	113103051161T	0	158428163	31105156951205060	10	82738
0135	383990	113112050991T	0	133428166	30975156449205060	-630	82103
0138	383990	113124051181T	0	125428171	30801156494205060	-410	82255
0260	383990	113246048829T	0	99428215	29031156960205060	-2160	81289
0103	383996	113162247841T	0	120428195	30247158052205069	-2000	81800
0043	384009	113 31648638T	0	69428175	32142159088205088	-250	83239
0384	384010	113132050781T	0	115428210	30686156946205090	-370	82425
0102	384015	113172946781T	0	100428234	30093158371205097	-2710	81430
0258	384040	113290053399T	0	190428325	28396154330205134	-560	81410
0131	384050	113 50050200T	0	86428256	31876158236205149	300	83286
0251	384050	113227048071T	0	82428319	29310157657205149	-2260	81422
0259	384050	113261049990T	0	112428332	28817156514205149	-1600	81462
0031	384072	113188546519T	0	83428345	29869158460205181	-2950	81263
0257	384080	113269050761T	0	135428390	28702156259205193	-1170	81645
0042	384096	113 24848839T	0	70428333	32244159127205216	-150	83280
0240	384140	113183046739T	0	77428469	29952158477205281	-2830	81307
0241	384140	113194047060T	0	75428473	29793158511205281	-2490	81535
0033	384168	113138647300T	0	87428505	30597159373205322	-1440	82507
0387	384170	113139047300T	0	86428509	30591159391205325	-1430	82526
0035	384174	113100047349T	0	93428503	31157159073205331	-1710	82233
0034	384178	113122947520T	0	85428518	30825159171205337	-1450	82425
0386	384180	113123047530T	0	85428322	30824159178205340	-1440	82435

WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN ELEV. +CODE	TER-COR. IN/OUT NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
0036	384181	113 92047500T	0 100428513	31273159274205341	-1370	82530
0038	384182	113 69550699T	0 117428507	31599158248205343	590	83437
0037	384186	113 80548271T	0 121428518	31440159294205349	-640	83021
0242	384190	113154046421T	0 80428551	30375159149205354	-2530	81720
0252	384190	113264050830T	0 131428592	28780156273205354	-1260	81541
0039	384193	113 53352129T	0 88428522	31835157335205359	1000	83328
0256	384210	113270051749T	0 133428631	28694155763205384	-930	81553
0255	384210	113300055531T	0 118428643	28259153359205384	200	81398
0040	384212	113 376507091	0 101428552	32063158234205387	540	83361
0032	384228	113174346270T	0 73428629	30082159103205410	-2770	81523
0041	384236	113 257498791	0 89428593	32236158788205422	280	83369
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0420	384248	113127046611T	0 79428649	30769159897205440	-1690	82499
0124	384270	113 17049219T	0 83428653	32364159149205472	-20	83283
0388	384270	113146045961T	0 73428696	30494159898205472	-2330	82073
0254	384280	113284053291T	0 105428766	28495154904205487	-440	81485
0123	384290	113 7048560T	0 72428686	32510159512205502	-300	83212
0104	384293	113184647441T	0 70428753	29936158607205506	-2260	81630
U771	384299	113 3148497T	0 70428702	32567159502205515	-380	83140
0253	384310	113250050810T	0 83428809	28989156686205531	-1040	81713
0105	384328	113195348061T	0 71428821	29783158298205557	-2040	81641
0244	384330	113201050449T	0 140428827	29700156686205560	-1410	81530
0130	384340	113 80046421T	0 92428803	31454160057205575	-1840	82422
0127	384350	113 61049760T	0 114428815	31730159169205590	380	83544
0421	384350	113128145289T	0 71428838	30757160593205590	-2380	82241
0106	384390	113213549482T	0 71428943	29522157640205649	-1450	81741
0423	384395	113117145240T	0 68428917	30919160573205656	-2520	82118
0422	384395	113128345240T	0 67428921	30757160480205656	-2610	82027
0129	384430	113 75046440T	0 87428968	31530159993205707	-2020	82227
0243	384450	113237050240T	0 75429063	29184156877205737	-1590	81355
0128	384460	113 57048550T	0 167429017	31792160042205752	-40	83577
0245	384470	113178047661T	0 67429078	30040159419205766	-1500	82307
0125	384480	113 35050479T	0 170429047	32112158908205781	600	83580
U770	384482	113 339500697	0 190429050	32128159165205784	470	83600
PV0179	382372	1133440 8829C	462398425261	27526128006202684	8435	80766
SL0163	384180	1131000 4746S	0 91428514	31157159082205339	-1594	82310
WV0003	383424	1131561 8460S	232308427135	30309133945204228	9353	82829
WV0012	383249	1131934 5381C	0 490426825	29760152746203971	-583	81554
WV0025	383250	1132170 4716S	0 200426835	29417155425203973	-4167	79949
WV0059	383876	1132715 5195V	0 156428014	28656155116204892	-886	81551
WV0063	383148	1132872 6335C	8 957426674	28392145091203823	892	80250

WAH WAH VALLEY GRAVITY DATA

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STATION  LAT.    LONG.  ELEV.  TER-COR. NORTH EAST   OBSV   THEO   FAA    CBA
IDENT. DEG MIN DEG MIN +CODE   IN/OUT   UTM   UTM   GRAV   GRAV         +1000

WV0065 383737 1132791 6616C  151260427760 28539145338204688  2920 81630
WV0074 383876 1133158 5970S    0 312428032 28013149987204892  1282 81232
WV0080 382879 1133318 8695V  283015426194 27730129486203427  7908 81294
WV0132 382296 1132065 5333S    0 508425067 29524149826202572 -2556 79763
WV0137 382695 113185356699T    0 343425779 29851150631203143   851 81855
WV0143 382710 1133310 8655C  402709425881 27733129640203180  7933 81163
WV0145 383790 1133159 6803C   28 463427872 28007144739204766  4004 81292
WV0146 383550 1133100 7036S   30 611427426 28081142178204413  3990 80633
WV0043 384224 1132493 5404C    9 169428649 28995154499205404   -48 81699
WV0077 382355 1133128 6091C   14 298425217 27980146235202659   903 80440
WV0078 382606 1133139 6387C    9 506425682 27976145083203027  2169 80900
WV0086 382240 1132832 6328C   19 438424992 28405144219202490  1287 80161
WV0095 381954 1132726 6481C    0 293424459 28545142311202070  1239 79427
WV0140 382282 1131674 6558S   13 344425027 30093143549202552  2721 80711
WV0142 382845 1133098 6650C    1 511426122 28048143751203377  2963 80794
TL0462 384171 1132830 6208C   21 543428564 28504148943205326  2045 81435
SL0151 384484 1131499 4541C    0   68429093 30448160945205787 -2108 82472
SL0152 384311 1131498 4576S    0   70428773 30441160015205532 -2454 82008
SL0153 384136 1131499 4738S    0   89428450 30432158793205275 -1894 82035
SL0154 383975 1131370 5140S    0 129428147 30612156631205038   -34 82564
SL0155 384010 1131320 5078S    0 115428210 30686156974205089  -326 82469
SL0160 384180 113123047520T    0   85428522 30824159186205339 -1435 82442
SL0161 383990 1131120 5099S    0 133428166 30975156639205060  -434 82308
SL0168 384182 113  92047500T    0 100428515 31273159282205342 -1360 82540
SL0171 384187 113  804  4827S    0 122428520 31442159319205350  -605 83053
SL0172 384337 113  798  4642S    0   94428797 31457160091205570 -1795 82466
SL0174 384425 113  748  4644S    0   89428958 31533160025205700 -1972 82278
SL0175 384241 113  695  4896S    0 145428616 31602159452205429    99 83545
SL0177 384458 113  567  4855S    0 184429013 31797160081205748    22 83647
TL0459 384072 1133110 5421S    0 544428392 28093154217205180    54 82109
TL0461 384224 1132935 5455S    0 120428666 28354154141205404    75 81590
TL0463 384310 1132604 5149S    0   95428813 28838156074205530  -999 81534
TL0464 384398 1132715 5238S    0   88428980 28682155477205660  -888 81335
TL0465 384484 1132715 5280S    0   81429139 28686154961205787 -1135 80937
TL0466 384484 1132493 5067S    0   88429130 29008156570205787 -1532 81274
TL0469 384223 1132272 4878S    0   76428639 29315158028205402 -1469 81970
TL0470 384137 1132160 4794S    0   75428476 29474158317205276 -1844 81880
TL0473 384397 1132272 4950S    0   74428961 29324157412205659 -1663 81528
TL0475 384397 1132053 4925S    0   70428953 29641157805205659 -1505 81767
TL0476 384329 113195148071T    0   72428823 29786158325205559 -1994 81682
TL0478 384137 1131941 4706S    0   75428468 29791158557205276 -2432 81592
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WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN	ELEV. +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
TL0480	384222	1131607	4611S	0	75428613	30279159352205401	-2656	81692
TL0482	384396	1131830	4760S	0	67428943	29964159090205657	-1772	82060
WV0001	384034	1131643	4771S	0	99428266	30218157914205125	-2312	81514
WV0004	383122	1131718	9660S	04390426582		30068123569203784	10725	82167
WV0005	383613	1131718	5437C	0	352427490	30090153798204505	460	82268
WV0006	383787	1131717	4947S	0	224427812	30100157232204762	-974	82378
WV0008	384049	1131829	4638S	0	88428301	29949158457205147	-3043	81226
WV0010	383700	1131828	4885S	0	201427655	29935156953204634	-1709	81830
WV0011	383526	1131828	5192S	0	363427333	29926154682204378	-834	81821
WV0013	383423	1131933	5167S	0	305427147	29769154053204227	-1546	81135
WV0014	383613	1131939	4750S	0	204427498	29769156808204505	-2997	81006
WV0015	383787	1131939	4637B	0	140427820	29778157665204762	-3459	80866
WV0017	384050	1132051	4696S	0	80428311	29627158373205148	-2583	81480
WV0018	383873	1132050	4641S	0	100427983	29621157919204888	-3294	80977
WV0020	383526	1132049	4681S	0	183427341	29606156773204378	-3553	80664
WV0021	383337	1132046	4841S	0	268426992	29601155465204100	-3076	80680
WV0022	383162	1132045	4828S	0	382426668	29594155055203843	-3352	80563
WV0023	383021	113200352569T		0	363426406	29649152854203636	-1308	81125
WV0024	383076	1132169	4783S	0	207426514	29410154732203717	-3971	79923
WV0026	383424	1132169	4667S	0	169427157	29427156285204228	-4024	80228
WV0027	383613	1132158	4639S	0	132427506	29451157120204505	-3731	80578
WV0029	383962	1132159	4704S	0	88428152	29467157996205019	-2755	81289
WV0030	384050	1132270	4808S	0	82428319	29310157690205148	-2211	81472
WV0032	383702	1132269	4653S	0	118427675	29295157738204637	-3114	81134
WV0033	383528	1132269	4680S	0	132427353	29286156702204381	-3637	80533
WV0034	383342	1132281	4703S	0	149427010	29260155697204108	-4152	79957
WV0035	383169	1132280	4752S	0	155426690	29253154852203853	-4282	79665
WV0036	383083	1132391	4781S	0	139426535	29088154498203727	-4234	79598
WV0037	383257	1132390	4751S	0	140426857	29098155235203983	-4037	79898
WV0038	383430	113239147798T		0	131427177	29104155899204237	-3356	80472
WV0039	383615	1132381	4753S	0	125427518	29128156958204509	-2822	81092
WV0041	383964	1132381	4825C	0	95428164	29145157676205022	-1938	81700
WV0042	384137	1132381	5092C	0	119428484	29153156452205276	-903	81848
WV0044	384050	1132492	4919S	0	97428327	28988156998205148	-1858	81462
WV0045	383877	1132491	4917S	0	114428007	28981157010204894	-1611	81732
WV0046	383703	1132493	4842S	0	172427686	28970156961204638	-2110	81547
WV0047	383528	1132501	4943C	0	139427362	28949155579204381	-2284	80996
WV0048	383343	1132501	4871C	0	148427020	28940154953204109	-3316	80219
WV0049	383169	1132502	4772S	0	152426698	28931155141203853	-3806	80070
WV0050	383083	1132613	4859S	0	161426543	28765154710203727	-3290	80298
WV0051	383257	1132612	4968C	0	163426865	28775154236203983	-2994	80225

WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN	ELEV. +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
WV0052	383430	1132613	5091C	0	152427185	28782154417204237	-1908	80880
WV0053	383615	1132603	5154B	0	196427527	28806154904204509	-1101	81517
WV0054	383789	1132604	5148S	0	154427849	28813155339204764	-978	81618
WV0055	383963	1132603	5018S	0	113428171	28823156151205020	-1646	81352
WV0056	384137	1132603	5050S	0	108428493	28831156521205276	-1230	81654
WV0057	384214	1132700	5175S	0	129428639	28694155793205389	-895	81584
WV0060	383552	1132751	5414C	0	206427416	28588152749204416	-715	81025
WV0061	383344	1132724	5170C	0	208427030	28617153203204110	-2252	80323
WV0062	383175	1132707	4965C	0	237426717	28633154292203863	-2845	80457
WV0064	383431	1132836	5611C	0	240427196	28458151082204238	-349	80753
WV0066	383963	1132824	5301S	0	143428179	28502154278205020	-854	81208
WV0067	384042	1132898	5340S	0	191428328	28399154245205137	-636	81342
WV0068	383876	1132936	5553S	0	197428023	28335152732204892	101	81358
WV0069	383529	1132948	5915S	0	288427381	28301149193204382	480	80593
WV0070	383006	113297655879T		0	227426415	28234150687203614	-335	80833
WV0071	383082	1133058	5924S	0	288426559	28118148680203726	708	80791
WV0073	383964	1133046	5727S	0	182428190	28180151818205022	695	81344
WV0076	383082	113316861142T		0	316426563	27958147829203726	1646	81109
WV0082	382778	1132958	5534C	0	247425993	28248150504203280	-693	80679
WV0083	382646	1132946	5379C	0	235425748	28259150745203086	-1718	80171
WV0084	382471	1132947	5486S	0	213425424	28249149927202829	-1272	80230
WV0085	382153	1132777	5830C	0	146424829	28481147514202363	21	80282
WV0087	382337	1132836	5693C	0	194425265	28406148420202705	-707	80070
WV0088	382557	1132836	5286B	0	174425579	28415151200202955	-2008	80137
WV0089	382735	1132838	5211C	0	180425908	28421151885203216	-2290	80116
WV0090	382924	113279051581T		0	171426256	28500152940203494	-2012	80566
WV0091	382810	1132720	5018B	0	155426042	28596153062203327	-3040	80000
WV0092	382645	1132727	5097B	0	144425738	28578152176203084	-2940	79819
WV0093	382471	1132726	5276S	0	141425416	28571150955202829	-2221	79925
WV0094	382300	1132726	5481S	0	157425099	28562149863202578	-1132	80331
WV0096	382085	1132671	5852C	0	132424700	28632146597202263	-589	79583
WV0097	382215	1132616	5517S	0	123424938	28718149196202453	-1335	79971
WV0098	382338	1132614	5304S	0	122425258	28730150729202707	-2061	79970
WV0099	382555	1132617	5112S	0	125425567	28733151861202952	-2981	79708
WV0100	382732	1132616	4975S	0	132425894	28743152975203212	-3418	79746
WV0101	382847	113259849150T		0	135426106	28775153575203380	-3553	79819
WV0103	382995	1132502	4829S	0	136426376	28922154258203598	-3895	79771
WV0104	382644	1132502	5019S	0	118425727	28905152441203083	-3408	79591
WV0105	382471	1132503	5177S	0	113425407	28895151311202829	-2796	79659
WV0106	382300	1132504	5369S	0	110425091	28885149863202578	-2186	79612
WV0107	382128	1132504	5521C	0	115424773	28877148629202326	-1731	79554

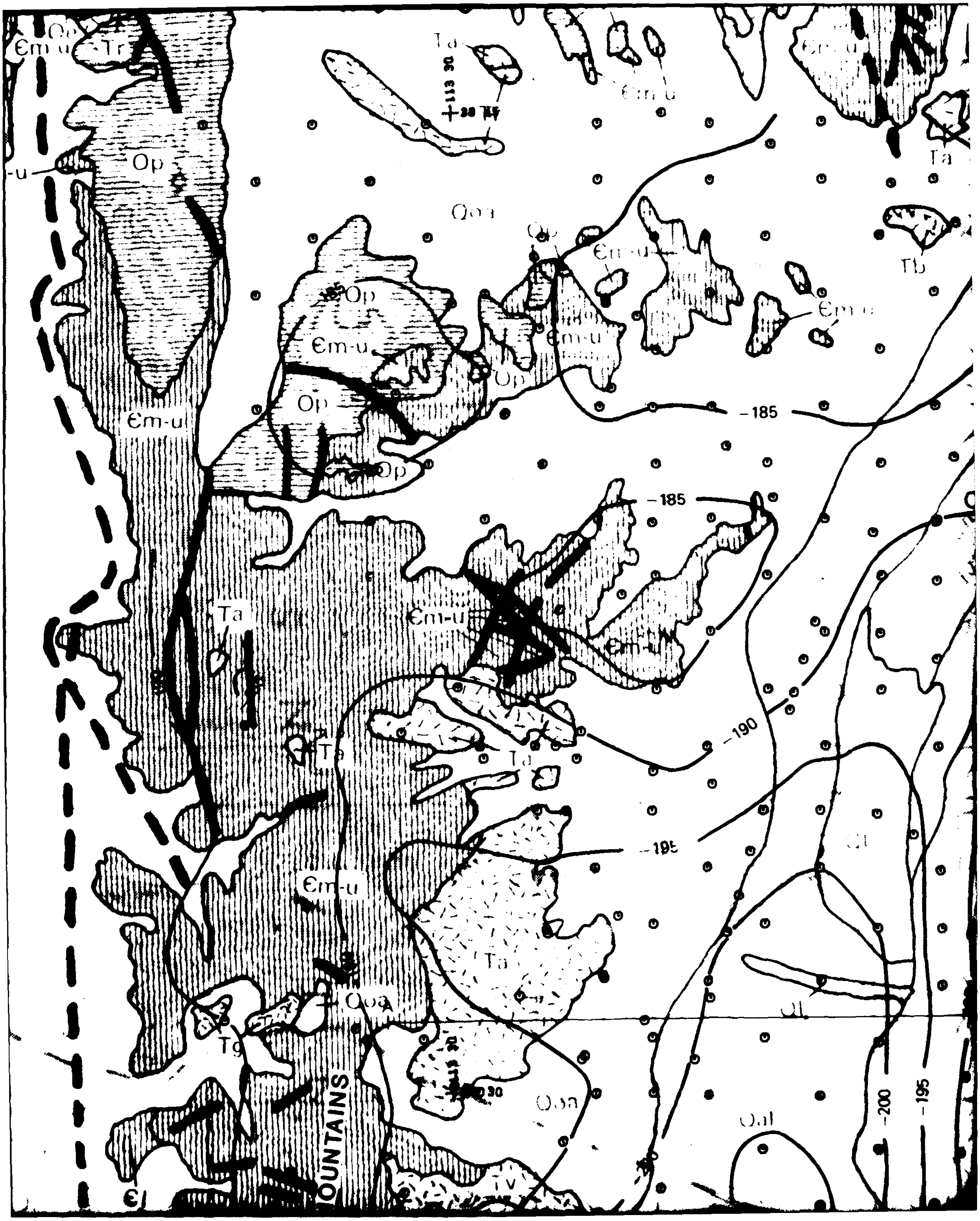
WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN	ELEV. +CODE	TER-COR IN/OUT NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
WV0108	381953	1132493	5694C	0 138424449	28885147447202069	-1033	79685
WV0109	381854	1132382	5613C	0 124424261	29042147673201924	-1424	79555
WV0110	382040	1132394	5481S	0 113424606	29033148798202197	-1815	79604
WV0111	382214	1132394	5347B	0 110424928	29041149811202452	-2318	79554
WV0112	382388	1132393	5222S	0 109425249	29051150637202707	-2925	79373
WV0113	382558	1132393	5072B	0 114425564	29059152027202956	-3197	79618
WV0114	382732	1132393	4955B	0 123425886	29068152815203212	-3765	79457
WV0115	382797	1132421	4918V	0 126426007	29030153213203307	-3811	79541
WV0116	382907	1132394	4864B	0 131426209	29075153611203469	-4084	79457
WV0117	382994	1132284	4819S	0 149426366	29239154114203596	-4132	79581
WV0118	382820	1132284	4909B	0 137426044	29231153155203341	-3988	79406
WV0119	382643	1132282	5013S	0 123425717	29225152458203081	-3446	79579
WV0120	382470	1132283	5135S	0 112425397	29215151452202827	-3050	79548
WV0121	382300	1132282	5257S	0 111425082	29209150306202578	-2798	79383
WV0122	382128	1132284	5407S	0 113424764	29198149567202326	-1872	79799
WV0123	381953	1132273	5566S	0 108424440	29205148974202069	-712	80412
WV0124	382209	1132172	5441S	0 114424910	29365150117202445	-1121	80435
WV0125	382388	1132173	5287S	0 112425241	29372150594202707	-2357	79723
WV0126	382559	1132172	5128S	0 124425557	29381152076202958	-2622	80012
WV0127	382737	113221149692T		0 141425888	29333152923203220	-3533	79660
WV0128	382906	1132169	4904S	0 176426199	29402153744203467	-3572	79878
WV0129	382822	1132062	5056S	0 215426040	29554153370203344	-2392	80579
WV0130	382649	1132064	5200S	0 156425720	29542151840203090	-2312	80108
WV0131	382472	1132065	5303S	0 136425392	29533151273202830	-1650	80399
WV0133	382567	1131953	5438B	0 175425564	29700151729202970	-62	81565
WV0134	382756	1131927	5480B	0 332425913	29747151764203247	90	81732
WV0135	382699	113201052431T		0 269426180	29633152702203457	-1410	80977
WV0136	382940	1131895	5820B	0 452426252	29802150679203517	1936	82538
WV0139	382606	1131749	5861S	0 288425629	29999149853203027	1988	82286
WV062A	383056	1132745	5078C	0 194426498	28572153628203688	-2275	80599
WV063A	383244	1132818	5431C	0 261426849	28475151399203963	-1452	80285
WV0141	382322	1131743	8132C	551932426028	30017134221203344	7424	81676
PV0030	383563	1133405	8918V	623153427462	27639129203204432	8721	81519
PV0031	383286	1133284	8980C	62671426945	27800128554204025	9063	81112
WV0144	383660	1132050	4639S	0 140427589	29610157309204575	-3609	80708
WV0028	383788	1132158	4651S	0 106427830	29460157627204763	-3367	80876
WV0040	383789	1132381	4732S	0 120427840	29136157733204764	-2500	81481
WV0002	383874	1131608	4900B	0 258427969	30262157505204889	-1271	82274
WV0009	383874	1131828	4660S	0 134427977	29943157959204889	-3076	81164
WV0031	383876	1132270	4734S	0 96427997	29302157806204892	-2536	81413
SL0154	383961	1131497	4993S	0 150428126	30427157227205017	-802	82319

WAH WAH VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN	ELEV. +CODE	TER-COR.	IN/OUT NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
WV0007	383961	1131718	4686S	0	124428134	30106158206205017	-2713	81429
WV0016	383961	1131940	4638B	0	98428142	29784158211205017	-3156	81122
SL0169	384048	113 945	5003S	0	168428268	31231158018205145	-44	83060
SL0155	384048	1131392	4954S	0	108428283	30583157896205145	-628	82584
WV0058	384051	1132714	5111S	0	133428338	28666155854205150	-1196	81504
TL0479	384136	1131719	4665S	0	79428458	30113158699205275	-2674	81494
SL0156	384180	1131330	4722S	0	85428525	30679159502205339	-1400	82580
SL0160	384196	1131180	4732S	0	83428550	30897159254205363	-1578	82366
WV0057	384214	1132700	5175S	0	129428639	28694155794205389	-893	81585
TL0477	384223	1131830	4715S	0	76428623	29956158535205402	-2496	81498
TL0471	384224	1132053	4799B	0	71428633	29633158467205404	-1775	81928
SL0157	384247	1131421	4609B	0	77428652	30550159871205438	-2193	82164
SL0159	384310	1131280	4554S	0	74428764	30757160493205530	-2182	82359
TL0481	384310	1131719	4630S	0	69428779	30121159427205530	-2533	81745
TL0468	384310	1132382	4990S	0	78428804	29160157228205530	-1342	81716
TL0460	384310	1132824	5311S	0	101428821	28519155040205530	-508	81478
TL0472	384311	1132160	4895B	0	69428798	29482157685205532	-1781	81593
TL0485	384396	1131608	4631S	0	65428935	30286159840205657	-2236	82034
TL0467	384397	1132493	5156S	0	78428969	29003156391205659	-745	81748
TL0484	384483	1131720	4747B	0	66429100	30127159567205785	-1546	82330
TL0483	384485	1131942	4941B	0	83429111	29806158421205788	-868	82363
TL0474	384485	1132272	5030S	0	92429124	29328157248205788	-1203	81733
SL0158	384398	1131378	4545Y	0	66428930	30619160383205660	-2506	82059
SL0159	384310	1131280	4554C	0	74428764	30757160487205531	-2188	82354
SL0161	384048	1131168	4993S	0	108428275	30908157280205146	-877	82202
SL0165	384397	1131171	4524C	0	68428921	30919160588205659	-2497	82141
SL0166	384404	1131026	4524C	0	71428929	31129160281205669	-2814	81826
SL0176	384325	113 616	4948S	0	154428769	31720159299205553	311	83589
TL0448	384484	1133048	5561S	0	94429152	28204153669205787	219	81346
TL0449	384397	1133157	5635S	0	110428995	28041153100205659	474	81364
TL0450	384484	1133269	5756S	0	110429161	27884152554205787	939	81417
TL0451	384484	1133489	6125S	0	154429170	27565150066205787	1926	81189
TL0452	384397	1133380	5943S	0	139429004	27718151074205659	1348	81217
TL0453	384310	1133269	5789S	0	136428839	27875152002205531	954	81345
TL0454	384310	1133046	5568S	0	111428830	28198153399205531	271	81391
TL0455	384224	1133380	6026S	0	206428684	27709150229205404	1539	81192
TL0457	384050	1133380	6263S	0	215428362	27700148518205149	2315	81169
UV0147	382998	1132611	4900S	0	146426386	28764154327203603	-3163	80271
UV0148	382998	1132723	5056S	0	166426390	28601153616203603	-2404	80517

END OF LIST



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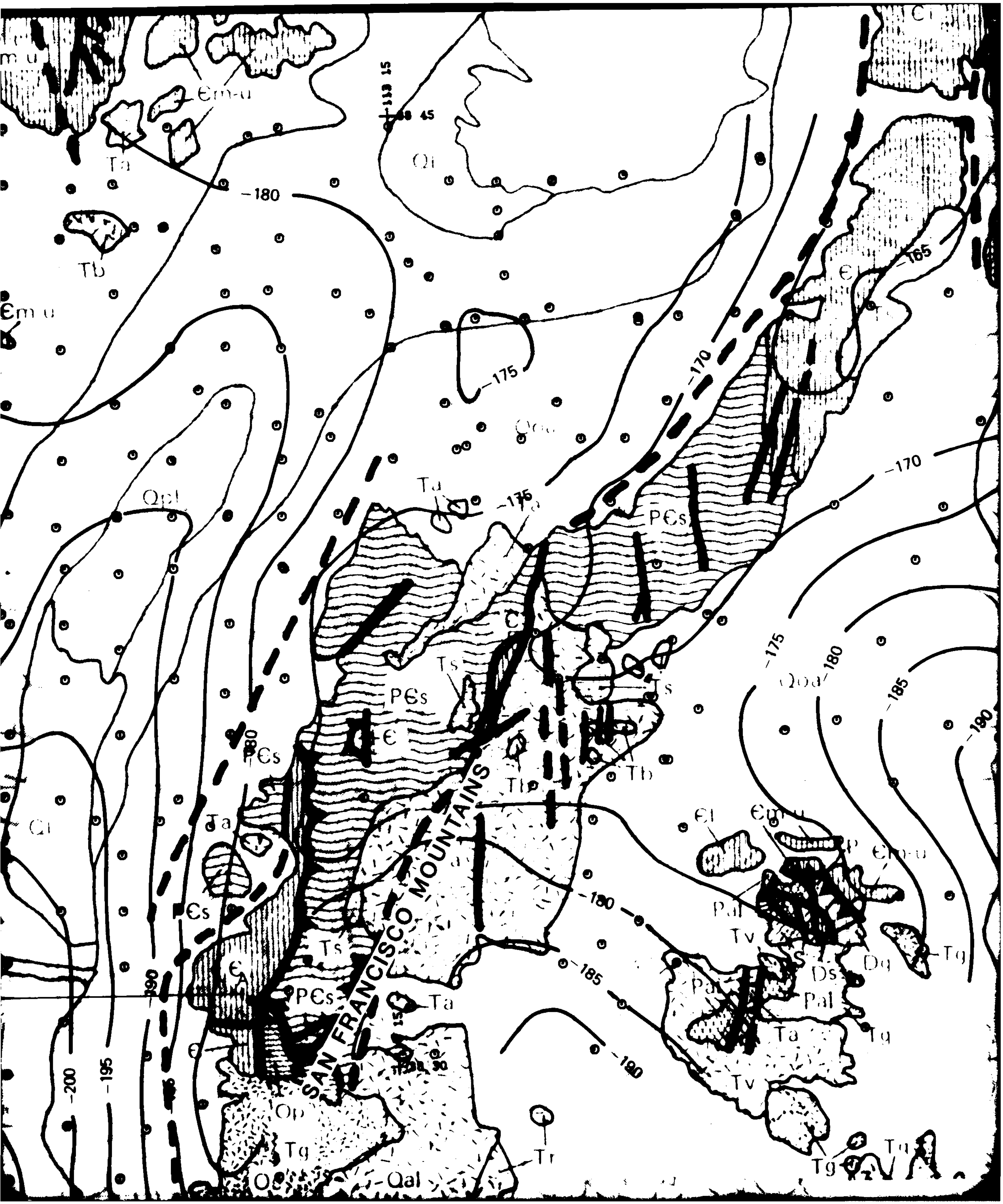
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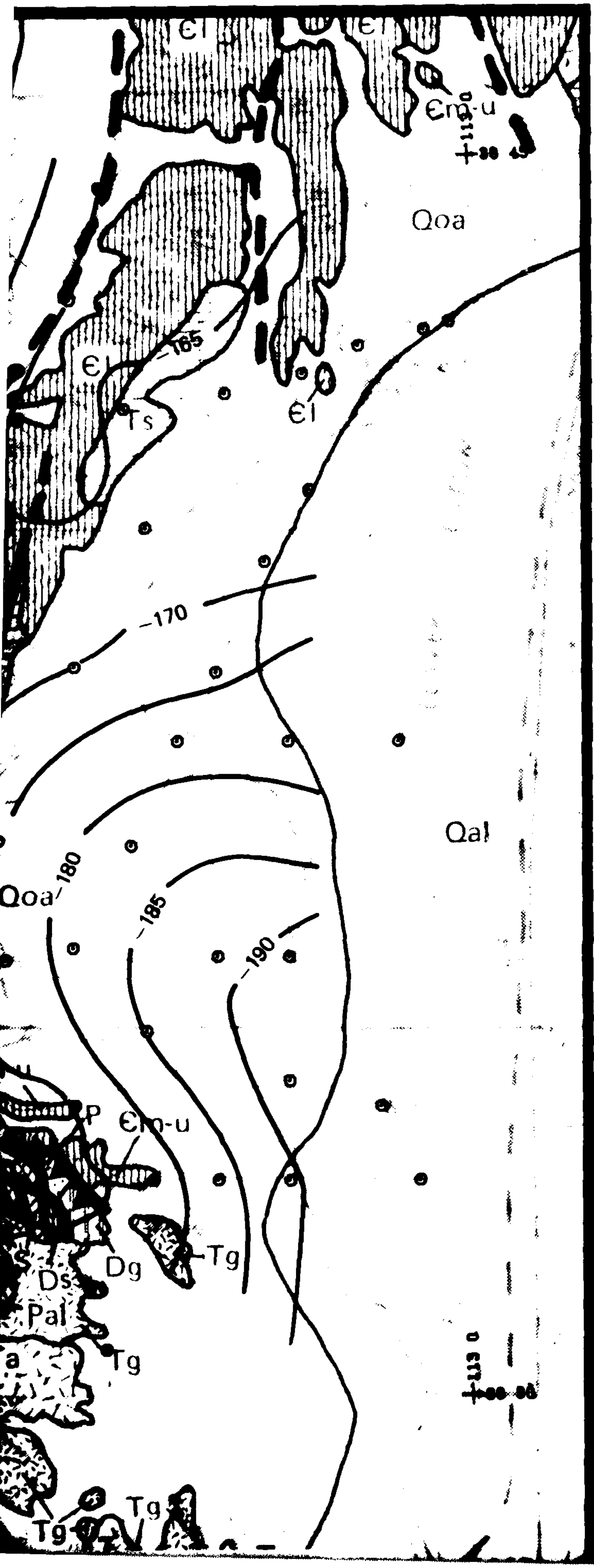

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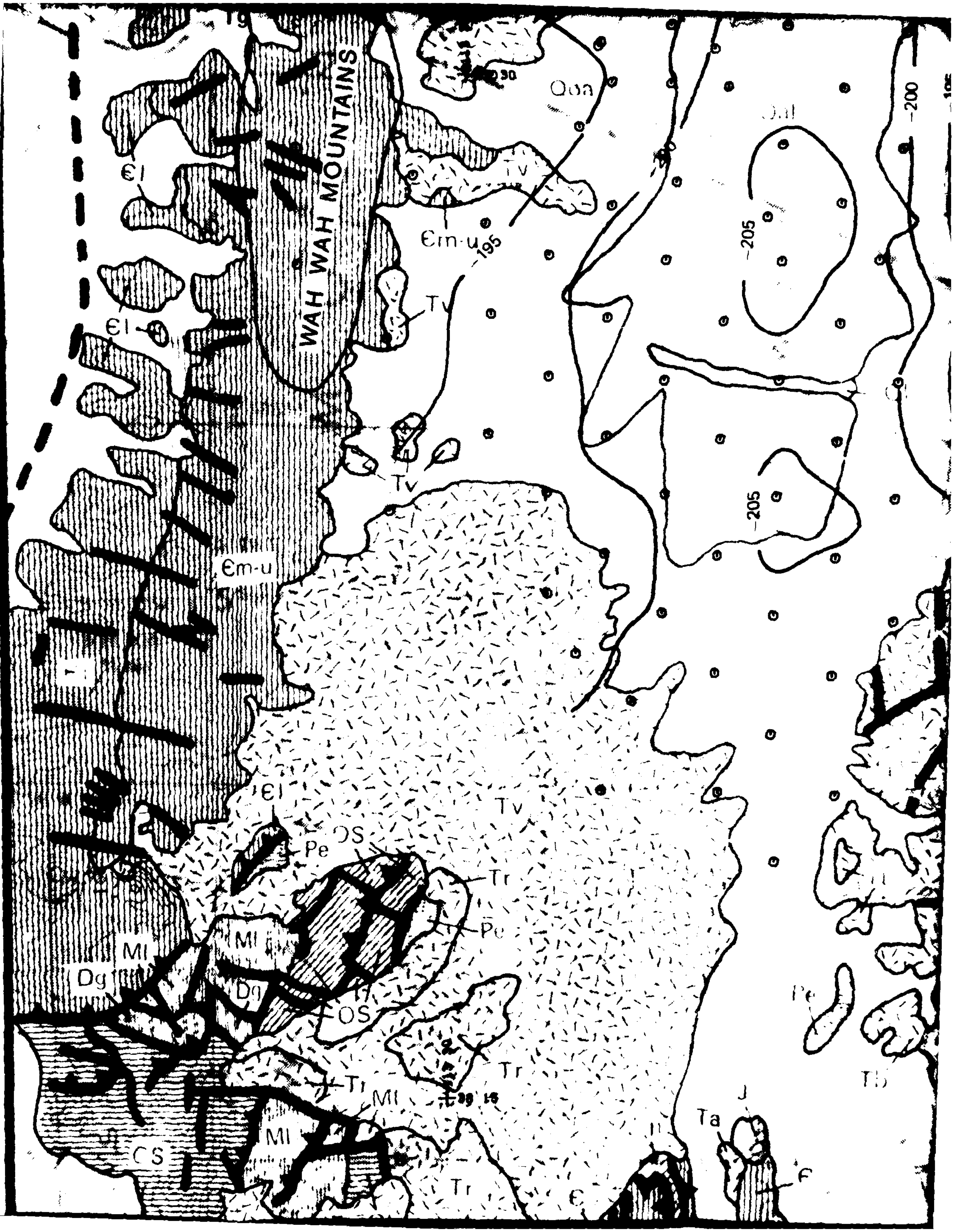
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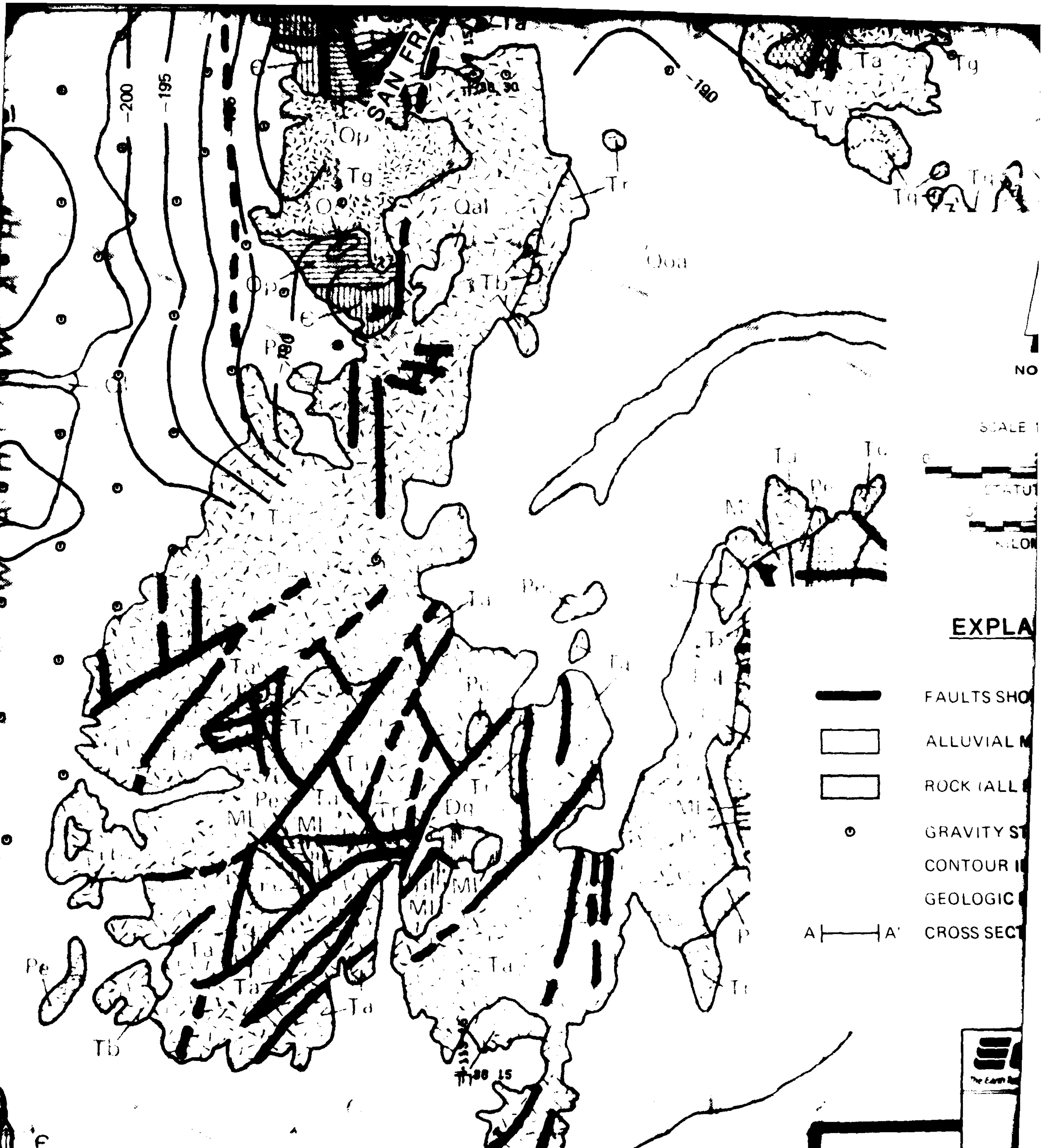

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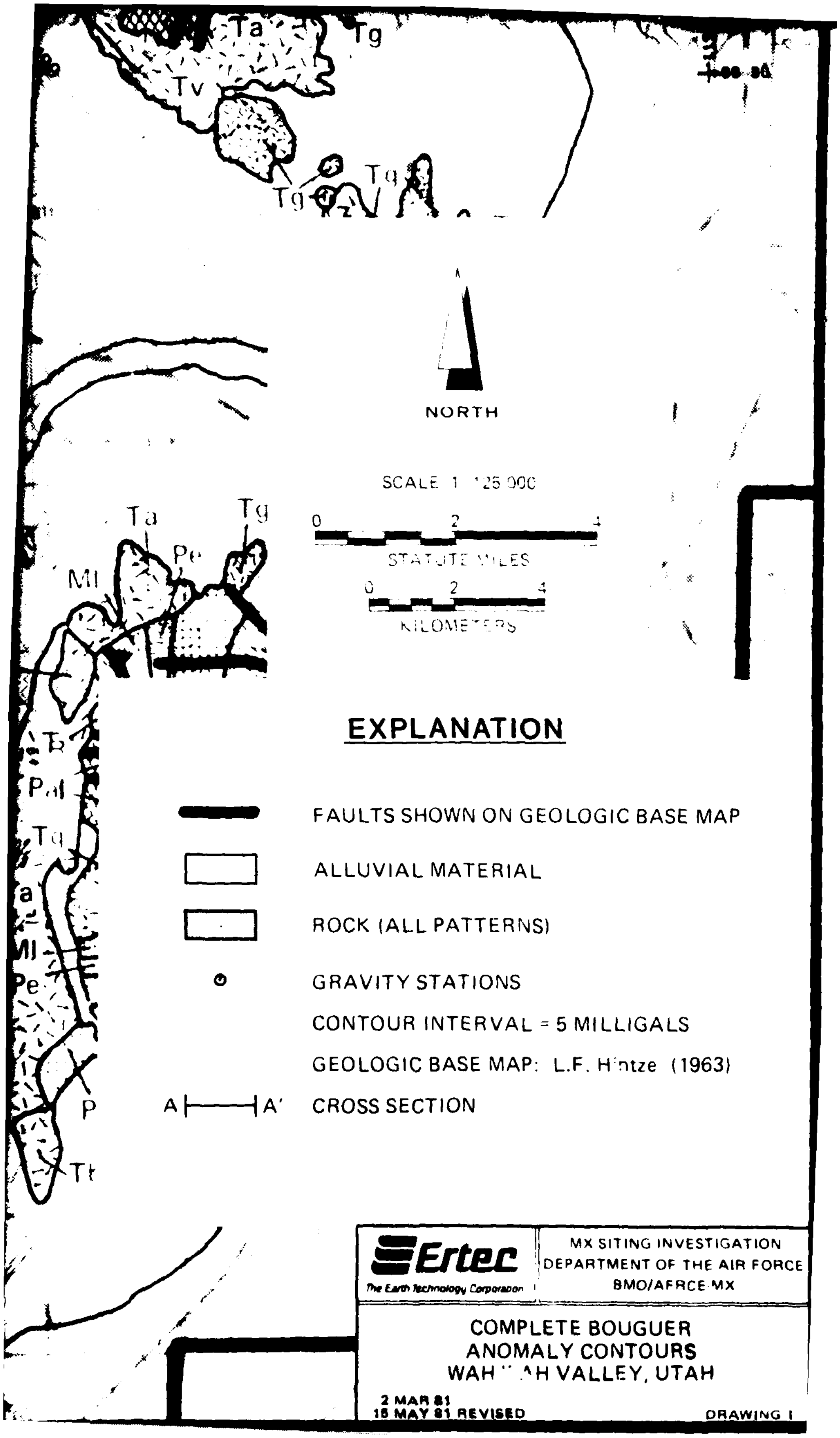
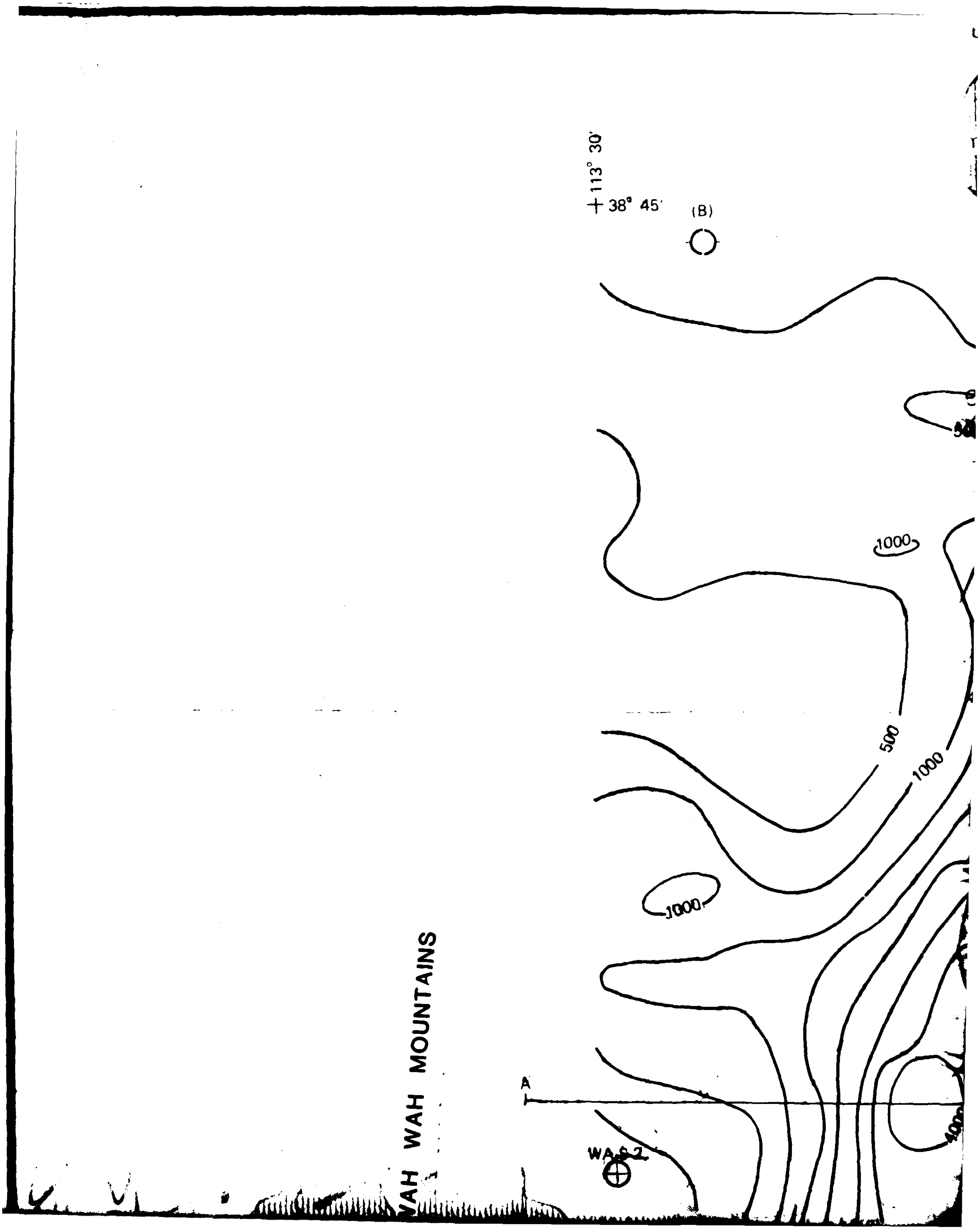
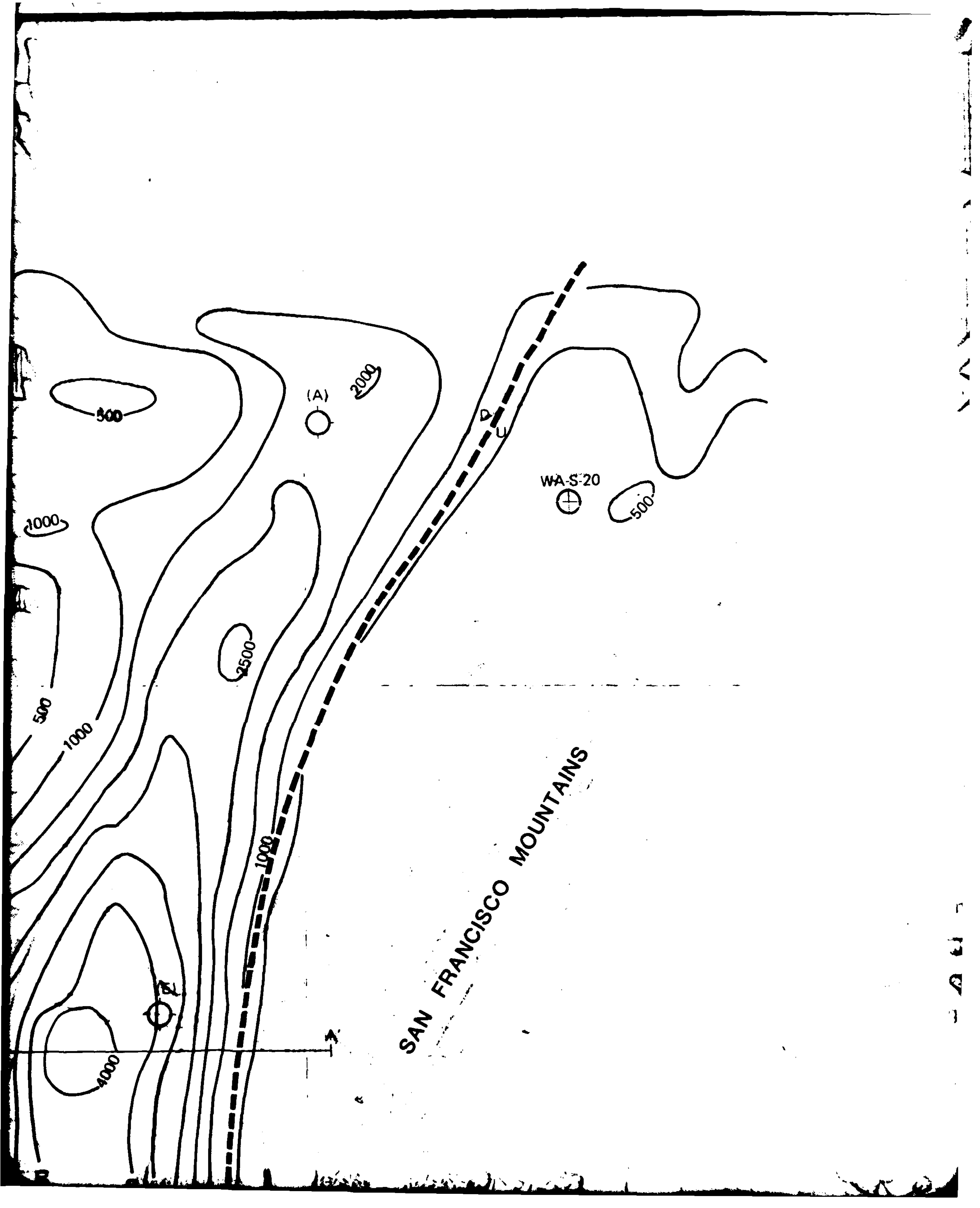


NORTH
SCALE 1 :125 000
STATUTE MILES
KILOMETERS
EXPLANATION
FAULTS SHOWN ON GEOLOGIC BASE MAP
ALLUVIAL MATERIAL
ROCK (ALL PATTERNS)
GRAVITY STATIONS
CONTOUR INTERVAL = 5 MILLIGALS
GEOLOGIC BASE MAP: L.F. Hintze (1963)
A A' CROSS SECTION
Ertec
The Earth Technology Corporation
MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX
COMPLETE BOUGUER
ANOMALY CONTOURS
WAH '' ^H VALLEY, UTAH
2 MAR 81
15 MAY 81 REVISED
DRAWING 1


113° 30'
38° 45'
(B)
1000
500
1000
1000
WAH WAH MOUNTAINS
A



500
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D
U
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500
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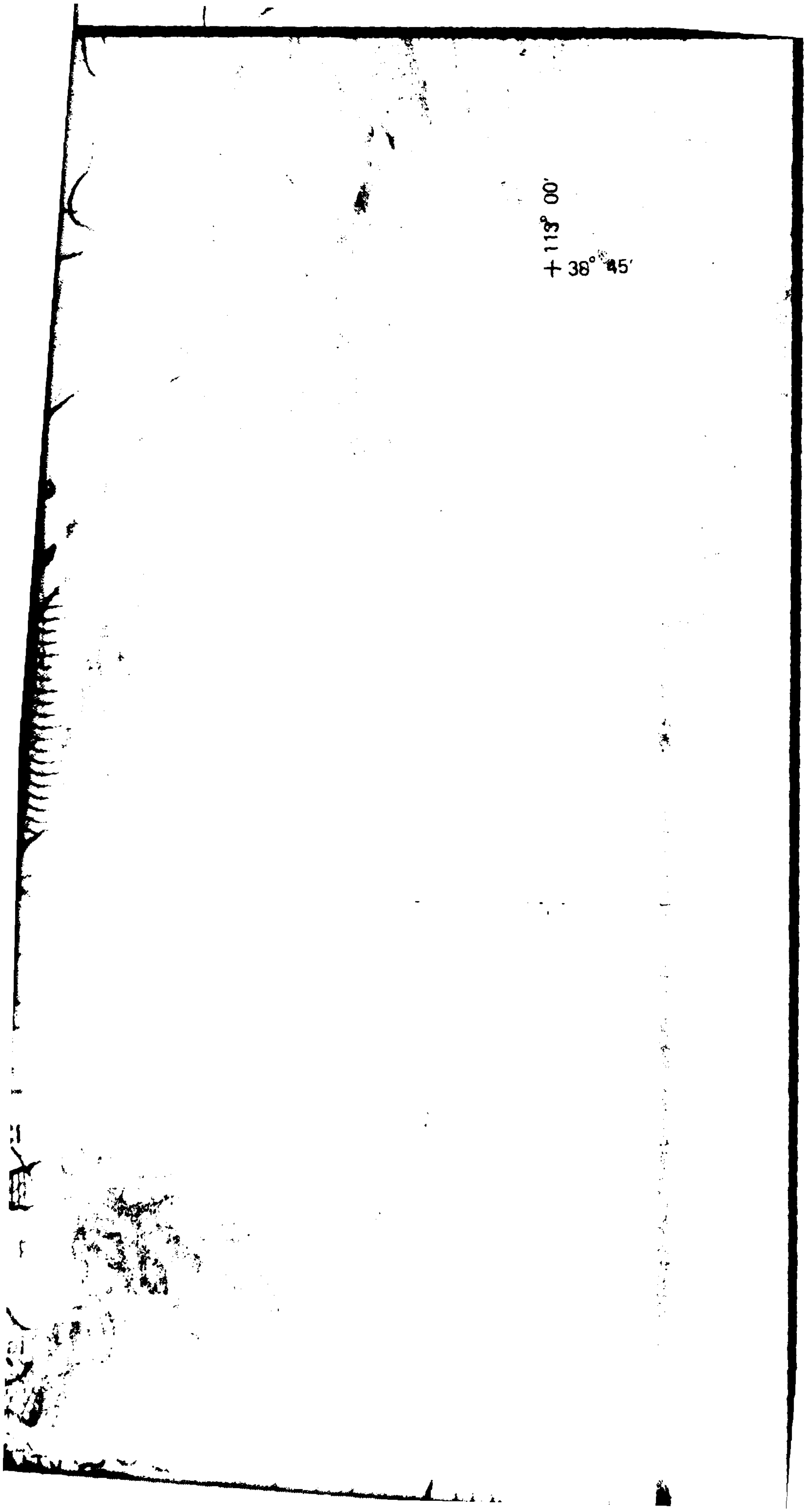
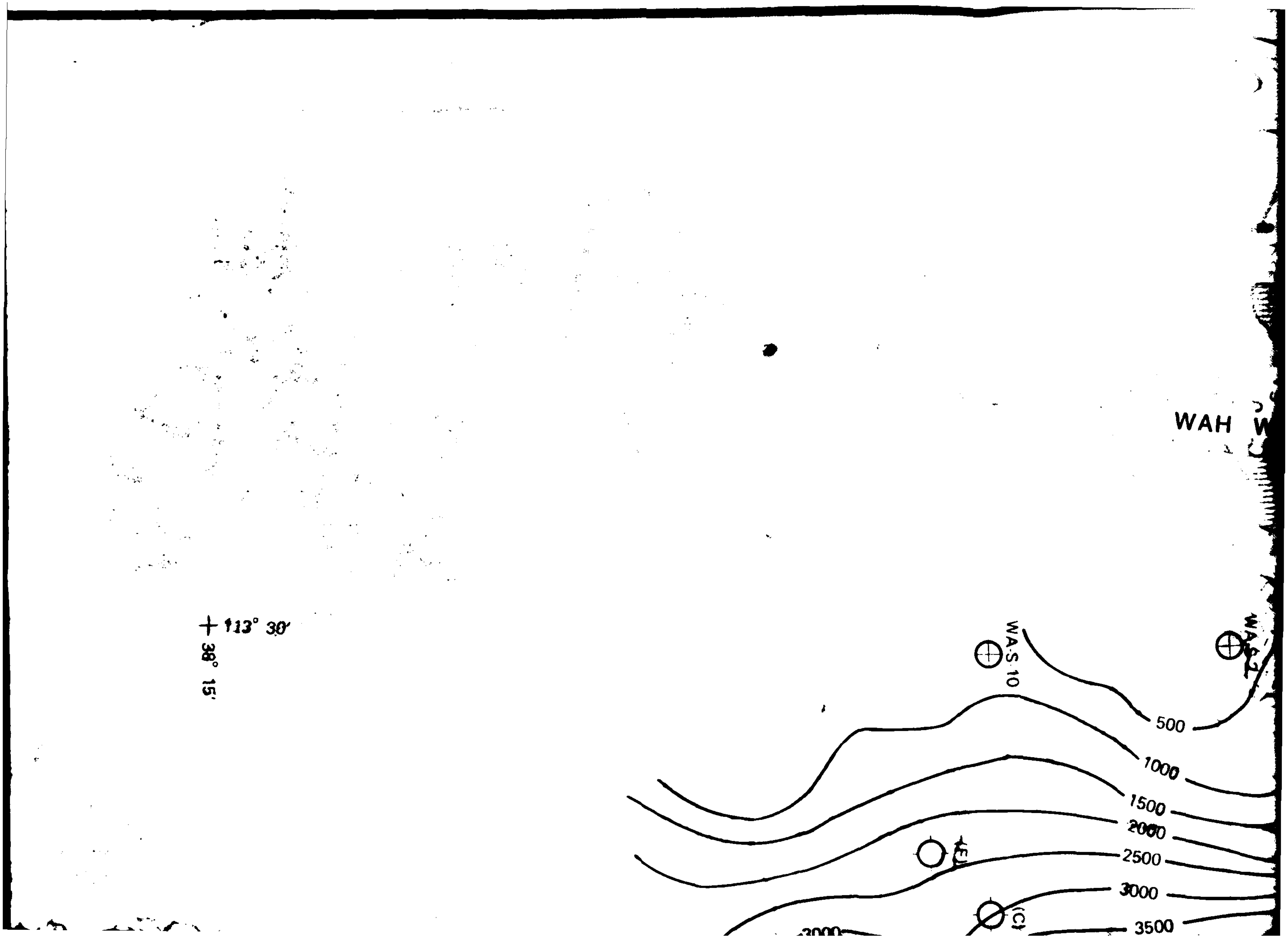
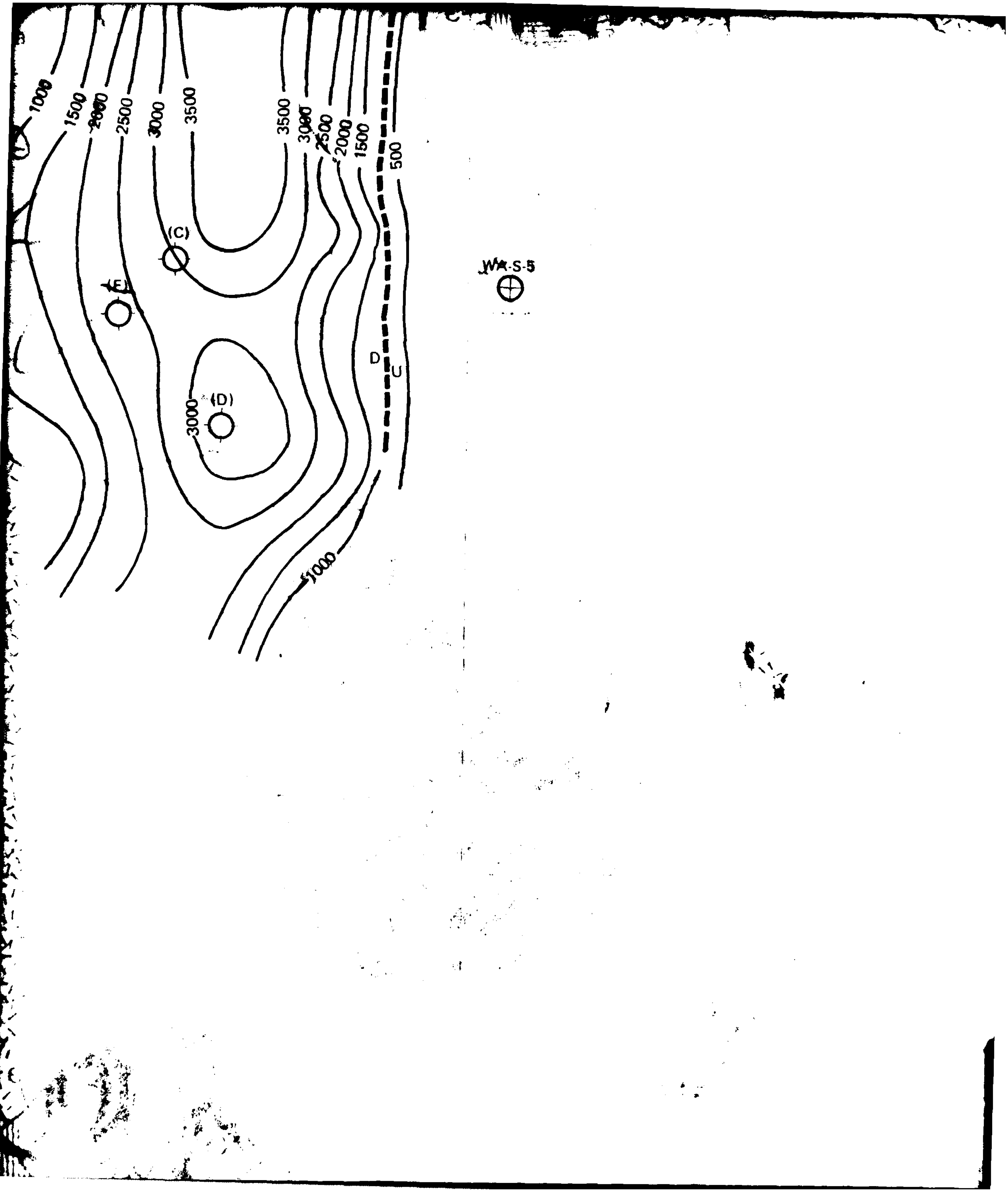
1000
1000
SAN FRANCISCO MOUNTAINS
4000


113° 00′
38° 45′


WAH
WA-S 2
WA-S 10
500
1000
1500
2000
2500
3000
3500
3000
(E)
(C)
113° 30'
38° 15'


1000
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(C)
(E)
(D)
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1000
WA-S-5

NORTH

SCALE 1:125,000

0 2 4

STATUTE MILES

0 2 4

KILOMETERS

EXPLANATION

U D GRAVITY INFERRED FAULT LOCATIONS

A A' LINE OF SECTION

FAULTS SHOWN ON GEOLOGIC BASE MAP

ALLUVIAL MATERIAL

ROCK (ALL PATTERNS)

CONTOUR INTERVAL = 500FT.

DEPTH CALCULATIONS BASED ON DENSITY CONTRAST OF -0.5g cm^{-3}

GEOLOGIC BASE MAP: L.F. Hintze (1963)

SELECTED VERIFICATION SEISMIC REFRACTION RESULTS

BORINGS FROM LITERATURE

Ertec
The Earth Technology Corporation

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE
BMO/AFRCE-MX

DEPTH TO ROCK INTERPRETED FROM GRAVITY DATA
WAH WAH VALLEY, UTAH

2 MAR 81
15 MAY 81 REVISED

DRAWING 2